# SCIENCE

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CONTENTS

*The American Association for the Advancement of Science:—*
*The Object of Astronomical and Mathematical Research:* DR. FRANK SCHLESINGER. 109

*The Place of Forestry among Natural Sciences:* DR. HENRY S. GRAVES ..... 117

*The University of Cincinnati Bureau of City Tests* ..... 126

*Mathematics, Astronomy and Physics at the California Meeting* ..... 127

*Scientific Notes and News* ..... 127

*University and Educational News* ..... 131

*Discussion and Correspondence:—*
*Occurrence of Silver Scurf of Potatoes in Salt Lake Valley:* DR. P. J. O'GARA. *A Simple Device for Counting Seeds:* ORTON L. CLARK. *The Journal "Isis":* PROFESSOR DAVID EUGENE SMITH ..... 131

*Scientific Books:—*
*Gwathmey and Baskerville on Anesthesia:* PROFESSOR J. H. LONG. *Sherman on Food Products:* PROFESSOR ISABEL BEVIER. *The Naturalists' Directory:* PRESIDENT J. C. BRANNER ..... 133

*Fraternity Grades at Purdue University:* PROFESSOR C. H. BENJAMIN ..... 135

*How can we Advance the Scientific Character of the Work done in the Agricultural Experiment Stations?:* SAMUEL BRADFORD DOTEN ..... 188

*Special Articles:—*
*A Device for Projecting a Small Spot of Light suitable for Exploring Photosensitive Areas:* BRADLEY M. PATTEN ..... 141

*The American Physiological Society:* PROFESSOR A. J. CARLSON ..... 142

*The American Mathematical Society:* PROFESSOR F. N. COLE ..... 144

*Societies and Academies:—*
*The Biological Society of Washington:* D. E. LANTZ. *The Science Club of the University of Wisconsin:* ERIC R. MILLER ..... 145

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## THE OBJECT OF ASTRONOMICAL AND MATHEMATICAL RESEARCH[1]

DURING the first years in the life of the American Association for the Advancement of Science it was customary for the members to meet in much broader groups than they now do. As the membership grew and as the number of papers increased, it became necessary to divide the association into smaller and smaller groups. Section A as we now know it was organized in 1882. It was a happy circumstance that the plan adopted in that year did not separate the astronomer from the mathematician. For a time this section played a very important part in the history of American science; the meetings were well attended and both the mathematician and the astronomer contributed numerous and weighty papers. In more recent years our section has lost something of its former influence. The establishment, about twenty-five years ago, of what is now the American Mathematical Society did much to draw away the interest of mathematicians; and even of astronomers, for in the records of that society we find a goodly number of purely astronomical papers, and two of the earliest presidents were astronomers. Fifteen years ago what is now the American Astronomical Society was formed, and this has still further increased the separation between the two sciences. It seems a great pity that the two should so seldom find themselves together in the same room. The astronomer, in common with the physicist, the chemist and

[1] Address of the vice-president and chairman of Section A, Astronomy and Mathematics, American Association for the Advancement of Science, Philadelphia, December, 1914.

others, greatly needs the help that the mathematician can give. On the other hand, I believe that the mathematician has something to learn from the astronomer with regard to the point of view from which he pursues his researches. The difference in this respect between the two is becoming greater and greater. In choosing a subject for an address this afternoon, I thought it best to take advantage of one of the rare opportunities that an astronomer as such gains audience with the mathematicians, and to dwell upon this difference of view-point, with the hope of aiding in bringing together those who have meat and can not eat, and those who would eat but want it. Any such attempt, however ineffective by itself and however feeble in itself, is well worth while.

This difference in view-point is nothing more than a recurrence of the struggle that occurs in every kind of human activity between the essentials of a subject and the technique of that subject. It is a remarkable fact that the outcome of this struggle is not always in favor of the former, but that mere technique is sometimes able to gain permanent mastery and to submerge completely the objects for which it was created. The best illustration of this is to be found in the painter's art. We know that there was a time when painting was regarded as a mode of expression through which lessons might be taught and learned, or through which at least the world might be amused. But for many a long day painters have refused to take this view of their art. They hold in frank contempt a picture that tells a story, and their standards of what constitutes a great picture are unintelligible to any one who is not himself a painter. You will remember the picture by Whistler, at the Metropolitan Museum of Art in New York, called "A Woman in White." Although executed in oils, it is wholly in black and white. We are told that it was painted to show that certain effects could be produced in oils without the use of color. Here then is a painting that artists deem a great one, although to the general public it has no subject at all and conveys next to nothing. The majority of modern paintings belong to the same class and it has gotten to be well understood that artists are to paint only for other artists. In any definition of a great painting, skill and technique are indispensable, but a man is at once called a Philistine if he asks that artists use their talents for some other purpose than merely to record and exhibit personal achievement.

Painting and poetry are arts that in their essentials are much the same, their chief difference being one of tools. But while the painter has glorified his tools more and more, the poet has kept his head, and has not forgotten what tools are for. I suppose it would be possible to construct a poem without using any other vowels than *o* and *u*. If so we should have the literary counterpart of Whistler's "Woman in White." Of course such an effort would not be regarded seriously for a moment, nor should we tolerate in literature any mere exhibition of technique. Yet technique is quite as indispensable here as in painting, and great facility is as rare in the one art as in the other.

Astronomy and mathematics have their technique and are having their struggle with it. A century ago Gauss, a great mathematician and a great astronomer, speaking for his times as much as for himself, announced as his motto, "Pauca sed matura," and adopted as his crest a tree laden with fruit, few in number but remarkable for their perfection. Such sentiments as these and the feeling that lay behind them have undoubtedly done more to hinder the progress of science than to ad-

vance it. If there is any question as to what Gauss meant, we have only to turn to his biography to find the answer. He did not care to touch in print any subject that he felt he could not exhaust; merely to contribute to it seemed to him like plucking unripe fruit. Thus his published work, extensive though it is, represents only a part, and it may be only a small part, of the unremitting labor of this wonderfully fertile brain. We know, for example, that Gauss had developed the principles of the method of least-squares while he was still in his teens, but it was not until fourteen years later that he ventured into print on this subject. He would doubtless have wished to delay even longer had not Legendre in the meantime unearthed and published the same principles. We can make a good guess at the reasons for Gauss's delay. The method of least-squares is founded upon an assumption which can be put in various forms, but which always remains an assumption. Gauss would doubtless have wished to prove this assumption from fundamental principles or at least to have given it a more axiomatic dress; but this neither he nor any one that has come after him has succeeded in doing. An even better illustration of the former attitude of men of science in the matter of their obligations to science, is afforded by Gauss's part in the history of non-Euclidean geometry. In a letter to a friend he states that he had occupied himself extensively with Euclid's axiom concerning parallels and goes on to outline very briefly some of the results he had obtained. This letter contains all that is known of these researches. A few years after it was written Lobatchewski published the little book in which he proves that the parallel axiom is no axiom at all, but a pure assumption, and shows that another kind of geometry is imaginable in which the opposite assumption is made. In view of this work, it would have been necessary for Gauss to revise what he had already done before publishing it. He preferred, however, to suppress it altogether, and when after his death his scientific effects were overhauled, no trace of this subject was found among his papers.

It will be understood that it is not Gauss that I am presuming to criticize, but rather the times in which he lived. That was an age when it was taken for granted that a man should think of his scientific reputation as coming first, and when the form in which he gave his researches to the world was considered as important as their content. In more recent times the man of science has taken a new view of his calling and of his duties, and it is largely because of this new policy that progress has been so rapid in some directions. In astronomy, for example, the great strides that have been made in the present generation can be attributed to two things; first, there is the unprecedented concentration of effort. Great telescopes have been erected and great observatories have been built for the purpose of solving single problems or a single group of closely related problems. If these problems should remain unsolved in our time the work will be carried forward by a succeeding generation and perhaps completed many years after those who initiated it have passed away. Cooperation is another powerful implement that time has placed in the hands of the astronomer, more precious to him than any telescope or any observatory can be. Thanks to it, no pressing problem appears at present above our horizon that is too great for him to attack. If you will examine the working programs of our astronomical institutions, you will find that much the greater half of what they are doing is being carried out with direct ref-

ence to the needs and the activities of other institutions. Cooperation often makes severe demands upon the individual; it means that he must be willing to use his mental and his material equipment in furthering an impersonal plan; it means that he must sometimes subordinate his own judgment to that of others; it means that he must sometimes use methods that he would to like to modify in some particular if he were working alone.

I believe that it is true that the astronomer has broken more completely with ancient tradition than has the mathematician. Many of the latter are still inclined to take what may be called the artistic view of their work; they refuse to admit that mathematics is a means to some other end, and they frankly assert (half in jest and half in earnest) that their science need have no reference to material things. A few years ago a prominent mathematician, speaking I think from the very chair that I am vacating to-day, quoted with sympathy the sentiment that mathematics is born and nourished out of the play instinct of mankind. It is difficult for me to see the difference between this view and the view that a chess player takes of his game. In the one we may start if we like with a set of axioms and an arbitrary set of postulates without inquiring whether they apply to the world around us, and we may then amuse ourselves by tracing the consequences. The chess-player does this very thing: he sets out with a set of axioms that he calls rules and a set of postulates that he calls openings, and after the expenditure of much thought and ingenuity he is able to trace the consequences.

It is understood, I hope, that I have been speaking in averages. By no means all astronomers have gotten rid of the artistic notion in their work, and by no means all mathematicians have severed their connection with the real world by applying the square-root of minus unity. But there is no denying that the idea of cooperation in a broad sense has not yet taken a strong hold in mathematics. Whether as great advantage would flow from cooperation between one mathematician and another, as is the case in astronomy, it is not for me to say. But when we come to speak of cooperation between mathematics and the other sciences, the benefits that would follow are difficult to overestimate. Let me spend a few minutes in pointing out how greatly the help of the mathematician is needed in a single astronomical subject, namely, that which concerns spectroscopic binaries. If in these remarks I emphasize individual stars, Algol for example, you will understand that these are types of a large class, and that the problems they present are of cosmical importance.

The first star to be recognized as variable in its light was probably Algol. The Arabs seem to have made this discovery, for it is difficult to account otherwise for the very apt name they gave the star, Algol or El Ghoul, the changing spirit or demon. The same discovery was independently made by others, among them Goodricke of England in 1782, when he was eighteen years of age. Goodricke continued to observe the star until he had determined the period and the nature of the light changes, and he advanced what we now know to be the true explanation of its changing light, namely that Algol is periodically eclipsed by a darker companion of nearly the same size as itself. This conjecture was a very bold one in that day, for we must remember that binary stars were then unknown. A great many double stars had been detected, but it was supposed that these were the result of perspective and chance. It was about this

time that Michell showed that on the doctrine of probabilities double stars were too numerous to be fortuitous groupings in all cases, so that binary stars were in a sense discovered by a mathematician and not by an astronomer. Twenty years later Herschel proved at the telescope that some double stars are real binaries, and that they revolve around each other by reason of their mutual attractions.

In 1880 Pickering showed that Algol's changes in light conform well with the eclipse explanation, and he suggested that the matter might be settled by the spectroscope. He argued that the orbital velocity of Algol due to the attraction of the dark companion should be considerable, and should change its sign according as the observations are made before or after the time of minimum light. The spectroscope was not quite ready at that time to handle problems of such delicacy, but a few years later Vogel succeeded in greatly increasing its accuracy for the determinations of velocities, by substituting the photographic plate for the human eye. Algol was among the first stars to be tested by Vogel, and his observations indicate precisely such velocities as the eclipse explanation implies. This explanation has been accepted without reserve since that time, and has been extended to all the numerous variables of the same kind that have in the mean time been discovered.

It was early noticed by Argelander and others that the period of Algol, the time between two successive light minima, is not constant. Attempts were made to represent these inequalities by formulæ involving the second and higher powers of the time, but the star refused to conform to such equations. In 1888 Chandler examined this question with great thoroughness; he showed that by the introduction of *periodic* terms all the observations up to that time could be well represented. The most important of these terms has a coefficient of 173 minutes and a period between 130 and 140 years. To account for this Chandler supposed that the system contains a third body, and that Algol and its eclipsing companion revolve around the common center of gravity of all three bodies in this long period. The dimensions of this orbit were supposed to be such that the light equation in it for an observer on the earth would be 173 minutes, and thus the eclipses would be advanced or delayed by this amount, according as they occur on the nearer or the farther side of this vast orbit. Chandler was quick to see that this explanation entails irregularities in the proper motion of Algol, and that these might be large enough to be unearthed from meridian observations. An examination of all the material of this kind then available convinced him that such an effect is really present, the coefficient of the oscillation coming out 1.″3, and its period 131 years. This result was apparently confirmed in a general way by Searle at Harvard Observatory, making use of additional observations secured for this express purpose. Baushinger, however, after applying to the catalogue positions the best available systematic corrections, concludes that there is no evidence whatever of a periodic term in Algol's proper motion. In the following year, Boss overhauled the same observations once more and decided that the probabilities were in favor of the presence of a term with a period of 131 years, but with a coefficient much smaller than that found by Chandler, 0.″5 against 1.″3. In later years Boss seems to have changed his mind as to the reality of this term; for in his Preliminary General Catalogue, published in 1910, he treats Algol as though its motion were uniform, although in the

case of other stars in this catalogue he devotes much attention to periodic inequalities.

It should be remarked that the absence of an appreciable periodic term in the proper motion does not necessarily imply the non-existence of Chandler's third body, since his theory does not demand any particular coefficient for this periodic term. The only condition is that that coefficient must be at least twenty times the star's annual parallax, and thus an accurate determination of the latter quantity would throw some light upon the present question. Unfortunately no determination of the parallax accurate enough for this purpose has as yet been made.

Starting with Chandler's inequality of 173 minutes, Tisserand has attempted an explanation that does not assume the presence of a third body. He shows that if Algol be slightly flattened and if the orbit of the eclipsing satellite be somewhat elliptical, the orbit itself will revolve slowly and uniformly in the same direction as the orbital motion of the satellite. Consequently the eclipses will occur earlier than the average time if the periastron point is in the half of the orbit that precedes eclipse, and later than the average if the periastron point is in the half that follows eclipse. This explanation is beautifully simple, and for a time seemed to be the key to the puzzle. I am able to say, not without some regret, that Tisserand's explanation is no longer tenable. In his memoir the following relation is established:

Period $\times$ eccentricity $=$ 3.1416 $\times$ the inequality. In this case the period is 2.87 days, and the inequality found by Chandler is 173 minutes; an eccentricity of 0.13 is therefore demanded, but this is out of the question. A long series of spectrographic observations made at the Allegheny Observatory shows conclusively that the eccentricity of this orbit can not possibly be as great as 0.13, that it is more likely than not to be under one fifth this amount, and that therefore no inequality greater than forty minutes can be plausibly accounted for in this way.

Shortly after Chandler's formula for the inequality was published, the star (always El Ghoul) thereafter began departing from it little by little, until now the eclipses occur more than an hour later than the formula implies. The character of the inequality is once more in doubt, but as the existence of some kind of inequality is beyond question, this does not lessen the necessity for an explanation.

While the chances in favor of the reality of Chandler's third body have been growing less and less, evidence has been steadily accumulating in favor of an entirely different third body in this system. Since the publication in 1890 of Vogel's classic observations, it has been well known that the radial velocity of Algol is affected by an oscillation whose semi-amplitude is about forty kilometers, and whose period is the same as that of the light changes, 2.87 days. In 1906 Belopolsky of Pulkova detected the presence of another oscillation in the radial velocity, the amplitude being much smaller than the other, and the period several hundred times as long. Observations made at the Allegheny Observatory have confirmed this discovery in an unmistakable way. The period of this new oscillation is found to be a little less than two years. It could be explained by the presence of a third body of such mass and so situated that the projected distance from Algol to the center of gravity of all three bodies is about two thirds of the distance from the earth to the sun. It is natural to inquire whether other explanations are not possible, or, in other words, whether the shifts in the spectrum lines from which this third body is inferred

may not arise from other causes than changes in velocity. This disturbing question is one that frequently recurs to the mind of the astronomer. Happily, in this case it can be answered in the negative without hesitation. The presence of the third body necessitates a light equation similar to that imagined by Chandler, but now of course with a period of less than two years and with a small amplitude. This amplitude can be computed in advance; we find that it amounts to about five minutes of time. I have examined the rich photometric material on this star accumulated in the second half of the nineteenth century and have found that this light equation is actually present. This seems to leave no doubt that the shift in the spectrum lines is nothing other than an effect of velocity and that the system of Algol contains at least three bodies, only one of which is visible in even our most powerful telescopes.

It is at this point that the man at the telescope must turn to the mathematician and ask him whether this third body can in any way produce the long inequality in Algol's period, that is, in the time that elapses between successive eclipses. If this should be found not to be the case, what dynamical explanations are possible other than those already tested and rejected?

The answer to these questions would doubtless apply to other eclipsing variables, for many of these show similar inequalities in their periods, though as yet in only one other case has the presence of a third body been demonstrated.

A somewhat similar problem is presented by the so-called secondary oscillations that have been announced for certain spectroscopic binaries. If we observe the velocities in a system as carefully as we can, we may draw a curve that expresses the relation between time and velocity. Curves of this sort from various stars will differ widely from each other, but all must conform to certain restrictions, which are in fact those that follow from Kepler's laws. Now for the majority of binaries this is found to be the case, and by assuming that the orbit of the body we have observed has certain dimensions, shape and situation, the velocity curve can be represented within the limits that the accuracy of the observations leads us to expect. But this is not always so: a number of spectroscopic binaries were found for which the velocity curve did not conform to simple elliptic motion. It was then assumed that the system must contain a third body whose attraction causes perturbations in the place and in the velocity of the bright component that we observe. By adopting suitable mass and distance for this body it was found possible to represent the velocity curve fairly well. Too much emphasis should not be placed upon such a representation, however; the assumption of a third body is very much like the adoption of additional pairs of Fourier terms in an empirical formula, and it would have to be a velocity curve of very complex form that did not resemble, within plausible limits, one of the great variety of curves that so many terms would yield.

It has developed recently that many of the cases in which secondary oscillations were apparently present could be explained as a systematic error of observation. This is caused by the presence on the plates of the spectrum of the fainter component which sometimes blends with that of the brighter in such a way as to distort the measures. Leaving out of account all the stars whose secondary oscillations can be explained in this way, we find that practically all the remaining cases are also variable in their light, but

not in such a way as to permit the eclipse explanation to apply. This circumstance causes the observer once more to inquire whether the shifts in the spectrum lines that he observes are always velocity effects, or at any rate whether they are due to orbital motion. These remaining cases have another peculiarity; the period of the secondary oscillation is always found to be either just one half or just one third of that of the principal oscillation. If we interpret this in terms of a third body we have a system in which the three components are close together and revolve around each other in simply commensurate periods. It is for the mathematician to say whether such a system can be stable, and therefore whether such a third body is possible. Although this is a problem of many years' standing it has not yet been approached from the mathematical side, so far as I am aware. It seems probable to the speaker that such a system will be found to be unstable, for reasons similar to those that account for the dark divisions in Saturn's rings and for the gaps in the distances of asteroids from the sun, these divisions and gaps corresponding to places where the periods would be simply commensurate to that of one of Saturn's satellites in the one case, and to that of Jupiter in the other. It is worthy of remark that in not a single instance where a third body has been inferred from a commensurate secondary oscillation, has this body been confirmed by a subsequent detection of its spectrum or otherwise. It is true that in Lambda Tauri two oscillations, both of short period, have been detected; but these periods seem to bear no relation to each other.

A mathematical problem connected with binaries, more important than either of the above, has to do with the origin of these systems. This is one of the few problems in sidereal astronomy with which the mathematician has concerned himself to any great extent, but it is still far from being in a satisfactory state. The past history of the moon, in a dynamical sense, formed the subject of an exceedingly laborious investigation by George Darwin more than thirty years ago. He concluded that the earth and the moon had once formed a single body and that they had broken away from each other by a kind of fission induced by the rotation of the body on its axis. Tidal friction is now set up; it causes the two bodies to draw away from each other, the month to become longer and the orbit of the moon to become somewhat eccentric. Darwin and others have extended this reasoning to double stars, and here the recent work on spectroscopic binaries seemed to afford a striking confirmation of the theory. It has been found that close binaries almost invariably have circular orbits and that their physical condition, as revealed by their spectra, is of the sort that is generally accepted as indicating youth. Widely separated binaries, on the other hand, are apt to have eccentric orbits and to show signs of old age. Still more recently the mathematical side of the question has been reviewed by Moulton, Jeans, Russell and others. It now appears that Darwin's results are at least incomplete and that the causes he adduces are not sufficient to account for the genesis of the moon or for that of double stars. The chief difficulty is that tidal friction is not competent to drive apart to any great distance two bodies of comparable mass that have separated by fission. It appears probable in this view that the separation must have occurred long before the bodies formed stars, that is, while they were still nebulæ. The difficulties of reconciling certain observational facts with this view are

great, but it would be out of place to recount them here.

We see that binary systems offer a rich field for the labors of the mathematician. Other subjects in astronomy are equally inviting, and I have no doubt that other sciences have as much to offer. An eminent psychologist, for example, has said that the time has come for a great mathematician to concern himself with psychological problems. There is a proverb to the effect that to him that is well shod the whole earth is covered with leather. And so the mathematician may walk where he pleases. What particular path he chooses is not a matter of great importance, but it is important that he be abroad and doing, and that he do not sit at home admiring his shoes.

Science has often been likened to a warfare, and such a simile as this naturally recurs to the mind at this time. We may think of science as at first occupying a small domain surrounded by the vast territories of the unknown. In the early days it was easier than now to add to this domain. A single bold spirit, starting out in almost any direction, could often wrest much from the adversary. But as the domain of science increases, so also do the extent and diversity of its boundaries. The more obvious points of vantage are already taken and the character of the warfare must change. The day of guerilla warfare is gone, it is now necessary to act in larger groups and for each man to be willing to serve at the side of others. This policy often requires the suppression of personal ambition, and deeds of individual heroism become less frequent; but great victories are to be won in either kind of warfare only if the soldier is imbued with such a spirit as this.

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## *THE PLACE OF FORESTRY AMONG NATURAL SCIENCES*[1]

IN an old forest magazine, *Sylvan,* is a story about Germany's great poet, Karl von Schiller. Schiller, taking rest at Illmenau, Thuringen, met by chance a forester who was preparing a plan of management for the Illmenau forest. A map of the forest was spread out on which the cuttings for the next 220 years were projected and noted with their year number. By its side lay the plan of an ideal coniferous forest which was to have materialized in the year 2050. Attentively and quietly the poet contemplated the telling means of forest organization, and especially the plans for far distant years. He quickly realized, after a short explanation, the object of the work and gave vent to his astonishment: "I had considered you foresters a very common people who did little else than cut down trees and kill game, but you are far from that. You work unknown, unrecompensed, free from the tyranny of egotism, and the fruit of your quiet work ripens for a late posterity. Hero and poet attain vain glory; I would like to be a forester."

An opinion not unlike that held by Schiller before meeting with the forester still commonly prevails in scientific circles in this country. It is quite generally believed that foresters are pure empiricists; something on the order of gardeners who plant trees, of range-riders who fight forest fires, or lumbermen who cruise timber, carry on logging operations or manufacture lumber and other forest products; that for whatever little knowledge of a scientific character the forester may need in his work, he depends on experts in other branches of science; on the botanists for the taxonomy of the trees, on physicists, chemists, and engineers for the proper understanding of the physical, chemical

[1] Paper delivered before the Washington Academy of Sciences on December 3, 1914.

and mechanical properties of the wood; on the geologist and soil physicist for the knowledge of sites suitable for the growth of different kinds of trees; upon the plant pathologist for the diseases of trees; upon the entomologist for the insect enemies of the forest, and so on.

Such an impression is undoubtedly strengthened when the activities of such an organization as the Forest Service are considered. The placing under management of about 200 million acres of forest land has been an administrative problem of enormous magnitude. The administration of this vast public property involves many large industrial and economic questions, and affects intimately a number of varied and important interests: the lumber industry, the grazing industry, water power development, navigation, municipal water supplies, agricultural settlement, mining development and the railroads. In launching this first great public enterprise, undertaken in the face of very strong opposition, administrative activities appeared to overshadow research work. In this way doubtless many scientific men have gained the impression that forestry has little to do with science, which seeks for the causal relationship of things and for the establishment of laws and principles, that forestry is rather a patch work of miscellaneous knowledge borrowed from other sciences and assembled without particular system to help the practical administrator of forest property.

My endeavor in this paper will be to show that this impression is erroneous. While it is true that forestry as an art, as an applied science, utilizes results furnished by the natural and engineering sciences, while it is also true that the forester's activities—particularly during the pioneer period of establishing forest practise—may be largely administrative in character, there is nevertheless a fundamental forest science which has a distinctive place. As with all others the science of forestry owes its distinctive character to its correlation from a certain point of view of parts of certain other sciences, such as mathematics, botany, entomology, civil engineering and chemistry. But these are only auxiliary to the resultant science—forestry—which rests upon a knowledge of the life of the forest as such, and which therefore depends upon the discovery of laws governing the forest's growth and development.

It is in this field chiefly that foresters may claim some scientific achievement, some contribution to general science. Sciences do not develop out of curiosity; they appear first of all because there are practical problems that need to be solved, and only later become an aim in themselves. This has been equally true of the science of forestry. The object of forestry as an art is to produce timber of high technical quality. In pursuing this object, the forester very early observed that tall, cylindrical timber, comparatively free of knots, is produced only in dense stands, in forests in which the trees exert an influence upon each other as well as upon the soil and climate of the area occupied by them. He further discovered that the social environment produced by trees in a forest is an absolutely essential condition for the continuous natural existence of the forest itself. If the forester had not found forests in nature, he would have had to create forests artificially in order to accomplish his practical purpose, since it is only through the control and regulation of the natural struggle for existence between trees in the forest that the forester is capable of managing it for the practical needs of man. Thus from the very nature of his dealings with the forest the forester was forced from

the beginning to consider the forest not merely as an aggregation of individual trees but as communities of trees—tree societies—and first from purely utilitarian reasons, developed a science upon which the practise of silviculture now rests.

Forestry as a natural science, therefore, deals with the forest as a community in which the individual trees influence one another and also influence the character and life of the community itself. As a community the forest has individual character and form. It has a definite life history; it grows, develops, matures and propagates itself. Its form, development and final total product may be modified by external influences. By abuse it may be greatly injured and the forest as a living entity may even be destroyed. It responds equally to care and may be so molded by skillful treatment as to produce a high quality of product, and in greater amount and in a shorter time than if left to nature. The life history of this forest community varies according to the species composing it, the density of the stand, the manner in which the trees of different ages are grouped, the climatic and soil factors which affect the vigor and growth of the individual trees. The simplest form of a forest community is that composed of trees of one species and all of the same age. When several species and trees of different ages occupy the same ground, the form is more complex, the crowns overlapping and the roots occupying different layers of the soil. Thus, for instance, when the ground is occupied with a mixed stand of Douglas fir and hemlock, the former requiring more light, occupies the upper story, and because of its deeper root system extends to the lower lying strata of the soil. The hemlock, on the other hand, which is capable of growing under shade, occupies the understory, and having shallow roots utilizes largely the top soil.

There are forest communities, such for instance as those typical of northwestern Idaho, where western larch, Douglas fir, western white pine, white fir, western red cedar and hemlock will all grow together. Such a forest is evidently a very complex organism, the stability of which is based on a very nice adjustment between the different classes and groups occupying the same ground. Any change in one of these classes or groups must necessarily affect the other. If, for instance, in the Douglas fir-hemlock forest, the Douglas fir is cut out, the remaining hemlock trees are likely to die out because their shallow roots are left exposed to the drying effect of the sun and wind. It is only by a thorough understanding of such mutual adjustments that the forester is capable of intelligently handling the forest. With the great number of species that are found in this country, with the great variety in climatic and other physical factors which influence the form of the forest, it is self-evident that there are many forest communities, each with distinctive biological characteristics, which offer a wide field for scientific inquiry. Amid the great volume of administrative phases of the work in the Forest Service this main objective has never been lost sight of in handling the national forests. The Forest Service is now spending nearly $300,000 annually for research work, it maintains eight forest experiment stations and one thoroughly equipped forest products laboratory, and is doing this work solely to study the fundamental laws governing the life of the forest and their effect upon the final product—wood.

Forestry may be called tree sociology and occupies among natural sciences the same position as sociology among humanistic sciences. Sociology may be based upon the physiological functions of man as a biological individual. A physician, however, is not a sociologist, and social

phenomena can be understood and interpreted only in the light of sociological knowledge. So also with forestry. Forestry depends upon the anatomy and physiology of plants, but it is not applied anatomy and physiology of plants. With foresters, anatomy and physiology of plants is not the immediate end but enters only as one of the essential parts without which it is impossible to grasp the processes that take place in the forest. As the science of tree societies, forestry really is a part of the larger science dealing with plant associations, yet its development was entirely independent of botanical geography. When the need arose for the rational handling of timberlands, no science of plant association was in existence. Foresters were compelled to study the biology of the forest by the best methods available; they used the general scientific methods of investigation and developed their own methods when the former proved inadequate. I am frank to admit that the present knowledge of plant associations in botany has not yet reached a point where foresters could leave wholly to botanists the working out of the basic facts about the life of the forests which are needed in the practise of forestry. When the general science of plant associations has reached a higher state of development, the two may possibly merge, but not until then.

In developing the science of tree associations, the forester has been unquestionably favored by the fact that the forests, being the highest expression of social plant life, afford the best opportunity for observing it.

The reason for the ability of forest trees to form most highly organized plant societies lies in their mode of growth. Each annual ring of growth, together with the new leaves that appear every year, are in reality new colonies of cells. Some of the cells die toward the end of the vegetative season; others continue to live for a number of years. When the conditions of life in a forest have changed for a certain tree; when, for instance, from a dominant tree it became a suppressed one, the new colonies of cells formed during that year, and which sustain the life of that tree, are naturally adapted to these new conditions. The same is true when a suppressed tree, through some accident to its neighbors, comes into full enjoyment of light. The last annual growth is at once capable of taking advantage of the new situation created in the forest. Therefore, as long as the tree can form annual rings, it possesses the elasticity and adaptability essential for trees living in dense stands. It is only when a tree is suppressed to a point when it can not form new growth that it dies and is eliminated from a stand. Because of the fact that the forest is the highest expression of social plant life, the foresters occupy the strategic position from which they command vistas accessible only with difficulty to other naturalists. In this lies the strength of forestry, its peculiar beauty, and the debt which natural science owes to it. It is a significant fact, although, of course, only of historic importance, that, according to Charles Darwin[2] himself, it was "an obscure writer on forest trees who, in 1830, in Scotland (that is, 29 years before the 'Origin of Species' was published), most expressly and clearly anticipated his views on natural selection in a book on Naval Timber and Arboriculture." For the same reason it was foresters, who, long before the word "ecology" was coined, have assembled a vast amount of material on the life of the forest as a plant association—the basis of their silvicultural practise. Warming, Schimper, and other early writers on ecology, borrowed most of their

[2] "Origin of Species."

proofs and examples from the facts established by the foresters, and the forest literature of to-day is still practically the only one which contains striking examples of the application of ecology to the solution of practical problems.

One discovery recently made at the Wind River forest experiment station in Oregon comes particularly to my mind. In northwestern Idaho where the western white pine is at its optimum growth and is greatly in demand by the lumberman, our former method of cutting was to remove the main stand and leave seed trees for the restocking of the ground. In order to protect the seed trees from windfall, they were left not singly but in blocks, each covering several acres. The trees left amounted often to from 10 to 15 per cent. in volume of the total stand, and since they could not be utilized later they formed a fairly heavy investment for reforesting the cut-over land. A study of the effect of these blocks of seed trees upon natural reforestation has proved that they can not be depended upon, at least within a reasonable time, to restock naturally the cut-over land. The distance to which the seed is scattered from these seed trees is insignificant compared with the area to be reforested. Splendid young growth, however, is found here and there on cut-over land, away from any seed trees, where the leaf litter is not completely burned. It is evident, therefore, that the seed from which this young growth originates must have come from a source other than the seed trees. The study of the leaf litter in a virgin stand showed that the latter contained on the average from one to two germinable seeds per square foot. Some of the seed found was so discolored that it must have been in the litter for a long time. Thus it was discovered that the seed of the western white pine retains its vitality for years while lying in the duff and litter beneath the mature stands, and then germinates when the ground is exposed to direct light by cutting. It was found similarly that in old Douglas fir burns, where the leaf litter was not completely destroyed, the young growth invariably sprung up from seed that had escaped fire and had been lying dormant in the ground. Should a second fire go through the young stand before it reaches the bearing stage, the land may become a complete waste, at least for hundreds of years, although there may be seed trees left on the ground. This conclusively proves that the young growth comes from the seed stored in the ground before cutting took place and not from the seed scattered after cutting by the seed trees left.

The wonderful capacity of the leaf litter and duff of the cool, dark forests of the Northwest to act as a storage medium for the seed until favorable conditions for its germination occur is confined not only to the Douglas fir and western white pine but to the seed of other species which often grow together with them, such as Noble fir, amabalis fir, western red cedar and hemlock. The subsequent appearance of other species in a Douglas fir or western white pine stand depends apparently to a large extent upon the seed stored in the ground at a time when the original forest still existed. This discovery revolutionizes our conception of the succession of forest stands, since it shows that the future composition of the forest is determined by the seed stored in the leaf litter; and the appearance of seedlings first of one species and then of another results simply from the differences in the relative endurance of seed of the different species that are lying in the ground. Besides being of scientific importance this discovery has also a great practical significance. It accentuates the disastrous consequence of a second fire in an old burn because no more seed remains in the ground while the capacity of the few

seed trees that may be on the burn is very limited in restocking the ground. This discovery enabled the service to change materially the present methods of cutting in the white pine and Douglas fir forests, to the mutual advantage of the government and of the logging operators.

I shall give briefly a few other illustrations of the life of the forest which stamp it as a distinct plant society.

The first social phenomenon in a stand of trees is the differentiation of individuals of the same age on the basis of differences in height, crown development and growth, the result of the struggle for light and nourishment between the members of the stand. A forest at maturity contains scarcely 5 per cent. of all the trees that have started life there. Yet the death of the 95 per cent. is a necessary condition to the development of the others. The process of differentiation into dominant and suppressed trees takes place particularly in youth and gradually slows down toward maturity. Thus, in some natural pine forests, during the age between 20 to 80 years, over 4,000 trees on an acre die; whereas at the age between 80 and 100 only 300 trees die. With some trees this natural dying out with age proceeds faster than with others. Thus in pine, birch, aspen, and all other species which demand a great deal of light, the death rate is enormous. With spruce, beech, fir, and species which are satisfied with less light, this process is less energetic. The growing demand for space with age by individual trees in a spruce forest may be expressed in the following figures:

| | Sq. Ft. |
|---|---|
| At 20 years of age ..... | 4 |
| At 40 years of age ..... | 34 |
| At 60 years of age ..... | 70 |
| At 80 years of age ..... | 110 |
| At 100 years of age ..... | 150 |

If we take the space required by a pine at the age between 40 and 50 years as 100; then for spruce at the same age it will be 87; for beech 79; and for fir 63. This process of differentiation is universal in forests everywhere.

Another peculiarity that marks a tree community is the difference in seed production of trees which occupy different positions in the stand. Thus if the trees in a forest are divided into five classes according to their height and crown development, and if the seed production of the most dominant class is designated as 100, the seed production for trees of the second class will be 88; for the third class, 33; for the fourth class only .5 per cent., while the trees of the fifth class will not produce a single seed, although the age of all these trees may be practically the same. The same struggle for existence, therefore, which produced the dominant and suppressed trees works toward a natural selection, since only those which have conquered in the struggle for existence, and are endowed with the greatest individual energy of growth, reproduce themselves.

In a forest there is altogether a different climate, a different soil and a different ground cover than outside of it. A forest cover does not allow all the precipitation that falls over it to reach the ground. Part of the precipitation remains on the crowns and is later evaporated back into the air. Another part, through openings in the cover, reaches the ground, while a third part runs down along the trunks to the base of the tree. Many and exact measurements have demonstrated that a forest cover intercepts from 15 to 80 per cent. of precipitation, according to the species of trees, density of the stand, age of the forest, and other factors. Thus pine forests of the north intercept only about 20 per cent., spruce about 40 per cent., and fir nearly 60 per cent. of the total precipitation that falls in the open. The amount that runs off along the trunks in some species is very

small—less than 1 per cent. In others, for instance beech, it is 5 per cent. Thus if a certain locality receives 50 inches of rain, the ground under the forest will receive only 40, 30 or 20 inches. Thus 10, 20 and 30 inches will be withdrawn from the total circulation of moisture over the area occupied by the forest. The forest cover, besides preventing all of the precipitation from reaching the ground, similarly keeps out light, heat and wind. Under a forest cover, therefore, there is altogether a different heat and light climate, and a different relative humidity than in the open.

The foliage that falls year after year upon the ground creates deep modification in the forest soil. The changes which the accumulation of leaf litter and the roots of the trees produce in the soil and subsoil are so fundamental that it is often possible to determine centuries after a forest has been destroyed, whether the ground was ever occupied by one.

The effect which trees in a stand have upon each other is not confined merely to changes in their external form and growth it extends also to their internal structure. The specific gravity of the wood, its composition, and the anatomical structure which determines its specific gravity differ in the same species, and on the same soil, and in the same climate, according to the position which the tree occupies in the stand. Thus in a 100-year-old stand of spruce and fir the specific gravity of wood is greatest in trees of the third crown class (intermediate trees). The ratio of the thick wall portion of the annual ring to the thin wall of the spring wood is also different in trees of different crown classes. The difference in the size of the tracheids in trees of different crown classes may be so great that in one tracheid of a dominant tree there may be placed three tracheid cells of a suppressed tree. The amount of lignin per unit of weight is greater in dominant trees than in suppressed trees.

Forest trees in a stand are thus influenced not only by the external physical geographical environment, but also by the new social environment which they themselves create. For this reason forest trees assimilate, grow and bear fruit differently and have a different external appearance and internal structure than trees not grown in a forest.

Forestry, unlike horticulture or agriculture, deals with wild plants scarcely modified by cultivation. Trees are also long-lived plants; from the origin of a forest stand to its maturity there may pass more than a century. Foresters, therefore, operate over long periods of time. They must also deal with vast areas; the soil under the forest is as a rule unchanged by cultivation and most of the cultural operations applicable in arboriculture or agriculture are entirely impracticable in forestry. Forests, therefore, are lagely the product of nature, the result of the free play of natural forces. Since the foresters had to deal with natural plants which grew under natural conditions, they early learned to study and use the natural forces affecting forest growth. In nature the least change in the topography, exposure or depth of soil, etc., means a change in the composition of the forest, in its density, in the character of the ground cover, and so on. As a result of his observations, the forester has developed definite laws of forest distribution. The forests in the different regions of the country have been divided into natural types with corresponding types of climate and site. These natural forest types, which by the way were also developed long before the modern conception of plant formations came to light, have been laid at the foundation of nearly all of the practical work in the woods. A

forest type became the silvicultural unit which has the same physical conditions of growth throughout and therefore requires the same method of treatment. The manner of growth and the method of natural regeneration once developed for a forest type, hold true for the same type no matter where it occurs. After the relation between a certain natural type of forest and the climate and topography of a region has been established, the forest growth becomes the living expression of the climatic and physical factors of the locality. Similarly, with a given type of climate and locality it is possible for the forester to conceive the type of forest which would grow there naturally. The forester, therefore, may speak of the climate of the beech forest, of the Engelmann spruce forest, of the yellow pine forest. Thus, if in China, which may lack weather observations, we find a beech forest similar to one found in northern New York, we can be fairly certain of the climatic similarities of the two regions. More than that, a type of virgin forest growth may serve as a better indication of the climate of a particular locality than meteorological records covering a short number of years. A forest which has grown on the same ground for many generation is the result not of any exceptional climatic cycle, but is the product of the average climatic conditions that have prevailed in that region for a long time. It expresses not only the result of one single climatic factor, but is the product of all the climatic and physical factors together. Similarly, the use of the natural forest types for determining the potential capacity of the land occupied by them for different purposes is becoming more and more appreciated. When the climatic characteristics of a certain type of forest, for instance those of Engelmann spruce in the Rocky Mountains, is thoroughly established, the potential capacity of the land occupied by it for agriculture, grazing, or other purposes is also largely determined.

Observations of the effect of climate upon forest growth naturally brought out facts with regard to the effect of forests upon climate, soil and other physical factors and led to the development of a special branch of meteorology, known as forest meteorology, in which the foresters have taken a prominent part. While there are some phases in forest meteorology which still allow room for disagreement, some relationships established by foresters are widely accepted. One of these is the effect which forests have upon local climate, especially that of the area they occupy and of contiguous areas. Every farmer who plants a windbreak knows and takes advantage of this influence. Another relation is that between the forest and the circulation of water on and in the ground, a relation which plays such an important part in the regimen of streams. Still a third one, as yet beyond the possibility of absolute proof, is the effect of forests in level countries, in the path of prevailing winds, upon the humidity and temperature of far-distant regions lying in their lee.

If in the field of botany the forester has contributed to the progress of botanical geography and in the realm of meteorology has opened new fields of investigation, his influence in wood technology has been in changing entirely the attitude of engineers, physicists and chemists in handling wood products. The methods of studying the physical, mechanical and chemical properties of wood were, of course, those used in engineering by chemists and physicists; but the forester has shown that wood, unlike steel, concrete or other structural material, is subject to altogether different laws. Wood, he has shown, is not a homogeneous product, but is greatly influenced by the

conditions in the stand from which it comes. Were it not, therefore, that mechanical properties can be tied up with some definite forest conditions and correlated with some readily visible expression of tree growth, such as the number of rings per inch or the specific gravity of the wood, timber would be too much of an indefinite quantity for architects and other users of wood to handle with perfect safety. To find such a relation is just what the foresters have been attempting to do and most of the studies of the strength of wood have been with the view of establishing certain relations between the mechanical, physical and anatomical properties of the wood. Some of these relations I may mention here.

One of the earliest relations which foresters have established with a fair certainty is that between the specific gravity of the wood and its technical qualities. Some of the foresters even go so far as to claim that the specific gravity of wood is an indicator of all other mechanical properties and that the strength of wood increases with the specific gravity, irrespective of the species and genus. In other words, the heavier the wood, all other conditions being equal, the greater its strength. Even oak, which formed apparently an exception, has been recently shown to follow the same law. If there is still some doubt that the specific gravity of wood can be made a criterion of all mechanical and technical properties of wood, the correlation between the specific gravity and the resistance to compression end-wise (parallel to the grain) is apparently beyond question. Thus by the specific gravity the resistance to compression end-wise can be readily determined. The compression end-wise equals 1,000 times the specific gravity minus 70, when the moisture contents of the wood is 15 per cent., or $C = 1{,}000S - 70$.

Since in construction work the most desirable wood is the one which possesses the highest strength at a given weight, the ratio between the compression strength and the specific gravity was found to express most clearly the strength of wood. This ratio, however, increases with the increase in the specific gravity, a fact which further substantiates the law that the specific gravity of wood determines its mechanical properties.

Another relation which has been fairly established is that between the resistance to compression end-wise and the bending strength of timber. (By the resistance compression end-wise, therefore, the bending strength of timber can be determined.)

One of the other properties of wood, namely hardness, was found to have a definite relation to the bending and compression strength of wood and this fact tempts the conclusion that by hardness alone all other mechanical properties can be determined. The test for hardness is very simple: it can be made even by a small manufacturer and therefore the whole problem of wood testing would be greatly simplified. Hardness was also found to have a definite relation to the proportion of the summer wood in the annual ring, and consequently to the specific gravity of the wood. The specific gravity of wood is determined by its anatomical structure, by the proportion of fibro-vascular bundles, their thickness and length, the proportion of thick-walled cells, medullary rays, etc. The anatomical structure in its turn is probably determined by the combination of two factors—the amount of nourishment in the soil and the intensity of transpiration. The mechanical properties of wood come, therefore, within the control of the forester who raises and cares for the forest.

There is another field of scientific endeavor in which foresters in this country may claim some credit. This is in the field

of forest mathematics. One unfamiliar with forest growth can hardly realize the difficulties in the way of measuring the forest crop, the amount of wood produced in a forest composed, for instance, of many different species, sizes and ages. If a tree resembled any geometric body, such as a truncated cone, or an Appolonian paraboloid, it would be a simple matter to determine its contents by applying the formula for such body. But a tree's form does not coincide with that of any known geometric body, so that it would seem that the only possible way of determining the contents of the trees forming a forest would be by measuring each single tree. Evidently this would be an entirely impracticable task.

The common practise of determining the contents of trees either in board measure or in cubic feet is to measure a large number of trees of a given species in a given locality and apply the average figures to the trees of the same diameters and heights within that locality. Since there are, however, a great many species of trees in this country, some of which have a very wide geographic range, this method necessarily involves the preparation of a large number of local volume tables and hence the measurement of hundreds of thousands of trees. The measurement of the taper of a large number of trees has shown that there are certain critical points along the stem of a tree, the ratio between which expresses the form of the tree in a sufficiently accurate manner. It was found that trees having the same total height, the same diameter breast-high ($4\frac{1}{2}$ feet from the ground), and the same ratio between the diameter at half the height of the tree and the diameter breast-high, must invariably have the same cubic contents irrespective of the species of the tree or the region in which it grows. Thus whether it be a Scotch pine of northern Sweden, a yellow pine of Arizona, a mahogany of the tropics, or a scrubby birch of the Arctic Circle, the volume of the tree may be expressed by means of one simple relationship. The discovery of this very simple relation provides for the first time a basis for the construction of a universal volume table. The mathematicians of the earlier period sought in vain to find a formula by which the cubic contents of a tree could be expressed. What the mathematicians failed to develop by the deductive method, foresters have found by the inductive method. With a reliable table for converting cubic measure into board measure for trees of different sizes the universal volume table expressed in cubic feet could be translated into a universal table expressed in board feet, which is the measure peculiar to this country.

There is another contribution of which I am somewhat hesitant to speak for it is not a contribution to pure science, if by science is meant only the physical or natural sciences. Since, however, it touches the interests of a large number of people, I may be forgiven if I say a few words about it. It is a contribution to what one economist has aptly called the "science of social engineering." The transfer of the forest reserves in 1905 to the Department of Agriculture marked a new departure in the national economic life. It recognized the new principle that the nation's resources should be managed by the nation and directly in the interests of the whole people; it recognized that these resources should be developed collectively rather than individually and indirectly. Nearly ten years have now passed since the inauguration of this policy. The record of what has been accomplished and the manner in which many of the problems have been approached and solved must unquestionably be considered a contribution to the methods by which similar problems may be handled by the nation in the

future. In the administration of the national forests there is being developed gradually what I believe to be a truly scientific system for attaining a concrete economic end, a system of controlling certain correlated industries with a single purpose in view—the maximum of the welfare of the nation as a whole. In spite of many mistakes which we have undoubtedly made and which we have attempted to correct as we went along, in spite of the lack of practise and experience in solving the problems at hand, this new policy, it seems to me, has already proved entirely safe and workable.

HENRY S. GRAVES

U. S. FOREST SERVICE

## *MATHEMATICS, ASTRONOMY AND PHYSICS AT THE CALIFORNIA MEETING*

A JOINT session of the American Mathematical Society, the American Astronomical Society and Section A of the American Association for the Advancement of Science will be held on Tuesday, August 3, at the University of California, for the presentation of two addresses:

The Human Significance of Mathematics: by Professor C. J. Keyser, Columbia University, New York.

The Work of a Modern Observatory: by Dr. George E. Hale, Mount Wilson Solar Observatory.

On Friday, August 6, the American Astronomical Society and others interested in astronomical research will make an excursion to the Lick Observatory, Mount Hamilton, near San José. The director of the Mount Wilson Solar Observatory, near Pasadena, extends a cordial invitation to men of science interested in astronomical and physical research to visit the observatory either before or after the San Francisco meeting of the association.

Physicists are invited to attend a joint session for mathematics, astronomy and physics on Tuesday, August 3. One session of the meetings devoted to physics will give consideration to recent spectroscopical investigations.

On the occasion of the visit of the association to Stanford University on Wednesday, August 4, Professor Harris J. Ryan will give demonstrations with high potential electric currents in the new laboratory which has been equipped for high potential experimentation.

## *SCIENTIFIC NOTES AND NEWS*

DR. CHARLES H. HERTY, professor of chemistry in the University of North Carolina, has been elected president of the American Chemical Society for the year 1915. The address of the retiring president, Professor Theodore W. Richards, of Harvard University, written for the Montreal meeting of the society which was abandoned on account of the war, has been printed in the *Journal* of the American Chemical Society for December. The subject is "The Present Aspect of the Hypothesis of Compressible Atoms."

THE Perkin medal of the Society of Chemical Industry will be conferred on Dr. Edward Weston on the evening of January 22, at the Chemist's Club, New York City. Dr. Charles F. Chandler will present the medal and an address will be made by Dr. L. H. Baekeland.

ON January 20, 1915, the Medical Society of the District of Columbia held a memorial meeting in honor of the late Dr. A. F. A. King, who died on December 13, 1914. The following appreciations were presented: In Memoriam, Resolutions by Committee, Dr. D. S. Lamb; Biographical Sketch, Dr. Henry D. Fry; Dr. King as an Author, Dr. Barton Cooke Hirst; Doctor King on Mosquitoes and Malaria, Dr. L. O. Howard; Doctor King as a Teacher, Dr. Sterling Ruffin; Doctor King as Dean of the Medical School, Dr. D. K. Shute; Personal Characteristics, Dr. A. R. Shands.

THE Rev. Sir John Twisden, formerly professor of mathematics in the Staff College of the British army, has died at the age of nearly ninety years.

M. ALFRED FOURNIER, formerly professor of dermatology and syphiligraphy at the University of Paris, has died at the age of eighty-two years.

British New Year's honors include two knighthoods conferred on scientific men—Dr. James Johnston Dobbie, F.R.S., principal of the government laboratories, formerly professor of chemistry at the University College of North Wales, and Frank Watson Dyson, F.R.S., astronomer royal since 1910.

Dr. Henry S. Drinker, president of Lehigh University, was re-elected president of the American Forestry Association at the meeting held in New York City last week.

Herr Karl Benz, founder of the German automobile firm, Benz and Company, has been given the doctorate of engineering by the Technical Institute of Karlsruhe.

The council of the Geographical Society of Philadelphia has authorized the holding of monthly meetings for study and research, in addition to the usual illustrated lectures on travel and exploration. The first of these meetings was held on the evening of January 15, when Professor D. W. Johnson, of Columbia University, addressed members of the society on "The Physiographic Features of Western Europe and Their Influence on the Campaign against France." Professor Johnson has also given illustrated lectures on the same subject recently before the New York Academy of Sciences, the Brooklyn Institute of Arts and Sciences, and the American Geographical Society.

"Our Natural Resources: Their Economic Significance," is the subject of a series of illustrated lectures to be given by Associate Professor J. Paul Goode, of the department of geography in the University of Chicago, beginning January 11, at the Berwyn center of the University Lecture Association. The purpose of the course is to discuss the great resources of the country from the point of view of their physical origin, and to trace the influence of these physical conditions on our daily social life. The subjects of the individual lectures are as follows: "The Evolution of a Continent," "Our Obligation to the Forest," "The Age of Steel," "The Social Significance of Wheat," "The Reclamation of Arid Lands," and "When the Coal is Gone."

An illustrated lecture was given by Professor R. D. Salisbury, dean of the Ogden School of Science, University of Chicago, on January 8, before the Southern Geographical Society, Knoxville, Tennessee. The subject of the lecture was "In and About Patagonia," and related to views and experiences of a stay of two months in that region for certain studies in connection with the Geological Survey of Argentina.

John A. Mathews, Ph.D., Sc.D., general manager of the Halcomb Steel Company, will deliver on February 1, an illustrated address upon "Iron in Antiquity and To-day" before the Syracuse University chapter of Sigma Xi and the Syracuse branch of the Archeological Institute of America, of which Dr. Mathews is vice-president. The lecture will be illustrated and the date is February fifth.

We learn from foreign journals that the memorial at Finse, Norway, in honor of Captain Scott and his companions was unveiled on December 28 by Dr. Skattum, vice-president of the Norwegian Geographical Society. The memorial has taken the form of a monument about 20 feet high bearing the names of the explorers—Captain R. F. Scott, Dr. Wilson, Captain L. E. G. Oates, Lieutenant H. R. Bowers and Petty Officer Evans—and an inscription reading: "Erected by Norwegians in honor of Antarctic research and heroic courage."

Dr. J. W. Spengel, professor of zoology at Giessen, has been elected a foreign member of the Royal Upsala Academy of Sciences.

Dr. Johann Hjort, director of the fisheries of Norway, lectured before the Washington Academy of Sciences and the Biological Society of Washington on January 19, his subject being "Migrations and Fluctuations of the Marine Animals of Western Europe."

An English correspondent informs us that Professor Albrecht Penck who, since his return from Australia with a load of geographical information, had been detained in London by the British government, was allowed to go back to Berlin on December 31, since it no longer seemed probable that the Germans

would have any opportunity for making hostile use of his knowledge. While in London Professor Penck has been given all facility for his studies in the government museums and libraries, and in the rooms of the Geological Society of London.

ACCORDING to *Das Umschau,* Dr. Oskar Idenzeller and his wife, sent last year by the Hamburg Museum of Ethnology to make explorations in northern Siberia, have been imprisoned. The St. Petersburg Academy of Sciences has sent a protest to the Russian minister of the interior.

THE Cutter Lectures in Preventive Medicine for the year 1915 will be given at the Harvard Medical School by Dr. Victor C. Vaughan, professor of hygiene and physiological chemistry and dean of the school of medicine and surgery of the University of Michigan, and Dr. Joseph Goldberger, surgeon, United States Public Health Service, Washington, D. C. Dr. Vaughan will lecture on "The Phenomena of Infection" on April 14, 15 and 16. Dr. Goldberger's subject will be "Diet and Pellagra" and will be given in one lecture on April 2. These lectures are given annually under the terms of a bequest from John Clarence Cutter, whose will provided that the lectures so given should be styled the Cutter Lectures on Preventive Medicine, and that they should be delivered in Boston, and be free to the medical profession and the press. Others interested are cordially invited.

DR. CLINTON WAGNER, formerly a well-known physician of New York, and first professor of laryngology and rhinology in the New York Post Graduate Medical School, has died in Switzerland at the age of seventy-four years.

SIR ROBERT SIMON, professor of therapeutics in the University of Birmingham, has died at the age of sixty-four years.

DR. KARL SCHNABEL, formerly professor in the Prussian mining school at Clausthal, has died at the age of seventy-two years.

PROFESSOR OTTO SACKUR has been killed by an explosion in the laboratory of the Kaiser Wilhelm Institute at Dahlem, where experiments in high explosives were being conducted.

DR. HERBERT STANGE, docent for chemistry at Giessen, and Dr. F. W. Hinrichsen, docent for chemistry at the Berlin Technical School, have been killed while serving as lieutenants in the German army.

DR. M. HEYDE, docent for surgery at Marburg, and Dr. Karl Müller, assistant in the Institute of Oceanography at Kiel, have died from typhoid fever contracted while serving as physicians with the German army.

THE Civil Service Commission of Cook County, Ill., will hold an examination during the latter part of January, 1915, for the position of director of the Psychopathic Institute of the Juvenile Court. The director is required to make a thorough physical and mental examination, including laboratory and psychological tests, of the delinquent and dependent children referred to the institute by the court, and must interpret the tests and make reports of the examinations for the guidance of the judge in deciding the cases. The position pays $5,000 per year, and any citizen of the United States may apply for entrance to the examination, but the applicants should have a medical degree or at least an experience in nervous and mental diseases, in practical psychology, or in psychopathic work among juveniles or adults, either in connection with courts or clinics. Persons interested in the examination may secure applications by addressing Cook County Civil Service Commission, Chicago, Illinois.

THE report of the proceedings of the general committee for promoting the establishment of an Imperial College of Tropical Agriculture is referred to in the *Pioneer Mail* of December 4 and quoted in *Nature.* It is stated that Mr. R. N. Lyne, director of agriculture, Ceylon, says he thinks that the West Indies will now support Ceylon's claims to be the home of the college. The committee resolved to take steps to raise £40,000 for building and endowing the college, of which £20,000 should be asked from the governments concerned, including India, and the remainder be raised by public sub-

scriptions, provided governments contribute the share stated. It was also resolved to collect £5,000 for the erection of a hotel for European students. The committee has not selected Ceylon for the site; at the same time it favors that country.

The weekly French scientific journal, *La Nature,* which suspended publication at the beginning of August, began again on December 12.

Dr. O. P. Hay, research associate of the Carnegie Institution of Washington, D. C., who is making a study of the Pleistocene vertebrates of North America for the institution, delivered before the Science Club of the University of Texas on December 21, an illustrated lecture entitled "The vertebrate fauna of the Pleistocene epoch." Dr. Hay called attention to the characteristic mammoth, mastodon, sloths, bisons and horses of the Pleistocene, showing illustrations of the skeletons, jaws, and restorations of the more prominent species. A series of maps was exhibited showing the distribution of the various species during various stages of the Pleistocene.

Under the auspices of the department of geology and geography of Harvard University a series of five public lectures will be given in the geological lecture room, University Museum, at 4 P.M. These lectures have been arranged in response to a real interest in the influence which geographic conditions have or may have upon the present European war.

Monday, January 18.—"The Physical Geography of Central and Western Europe." (Illustrated.) Professor William M. Davis.

Wednesday, January 20.—"Some Military Features along the Western Front." Professor Robert M. Johnston.

Monday, January 25.—"European Weather and the War." Professor Robert DeC. Ward.

Wednesday, January 27.—"The Food Supply in Europe." Professor Thomas N. Carver.

Friday, January 29.—"Mineral Resources of Central and Western Europe." Professor Henry L. Smyth.

In connection with these lectures certain maps and charts of special geographic interest will be displayed in the lecture room, which will be open at 3:30 on the days of the lectures.

The legislature efficiency committee, in its report on the administrative system of Illinois which appeared December 7, makes according to the *Journal* of the American Medical Association the following recommendations: The reorganization of the various health agencies into a state health department to be under the direction of a salaried health commissioner; an unpaid state health board of five officers to be appointed by the governor; the state health department to have supervision over the examination and licensing of physicians, pharmacists, dentists and nurses, and the regulation of those organizations which carry on other professions and trades for the protection of public health; a small board or committee to be provided for each profession to arrange for examinations, issue licenses and to revoke same for cause; the clerical and administrative work in connection with such examinations to be handled through one office and the action of the examining boards in revoking licenses, to be subject to review by the state board of health. The board of barbers' examiners to be abolished and the power of sanitary control over barbers to be exercised by the health department; the law for the collection of vital statistics to be made more effective; the pharmacy law to be revised; the cold storage of food products to be regulated and a state sanitary code to be enacted.

Part of the government's exhibit for the Panama-California exposition at San Diego leaves Washington this week. This portion has to do with the national forests of New Mexico, and will be shown in the New Mexico building, the exhibit having been prepared in cooperation with the state board of exposition commissioners of that state. The material also shows specimens of the principal timber trees of New Mexico and their uses. Other exposition material is to leave soon for San Francisco, where it will form a part of the Panama-Pacific exposition. Part of this is being prepared through cooperation between the forest service and the United States civil service commission. The commission passes on the qualifications of all candidates for

positions in the forest service, testing the fitness of those who wish to become forest officers through outdoor examinations in riding, surveying, timber estimating, and similar matters as well as by more conventional methods; its exhibit will illustrate the duties of these officers. Cooperation also exists in the preparation of exhibit material, between the forest service and the bureau of education. This shows how forest subjects are used in the public schools, in connection with nature study, commercial geography, agriculture and the like. One of the exhibits is a display made by the normal school pupils of the District of Columbia, in which a number of those who are studying for teachers' positions entered a prize contest on tree study. Each of the contestants prepared a separate exhibit showing the life history and the products of individual trees, such as white pine, hickory or sugar maple.

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## *UNIVERSITY AND EDUCATIONAL NEWS*

POMONA COLLEGE, Claremont, Cal., has completed the collection of an endowment fund of one million dollars toward which the General Education Board contributed $150,000.

MRS. RUSSELL SAGE, who had undertaken to give $100,000 towards a $500,000 dining hall for Princeton University, has increased her offer to $250,000, provided an equal sum is collected by July 1. Sums amounting to $75,000 have been subscribed, of which $30,000 are due to efforts of the sophomore class.

BY the will of the late Dr. T. Bell, of Newcastle, the sum of £3,000 is bequeathed to the Armstrong College.

DR. P. J. ANDERSON, formerly field pathologist with the Pennsylvania commission for the investigation and control of the chestnut blight disease, has been appointed instructor in botany at the Massachusetts Agricultural College.

DR. HARRY M. ULLMANN has been made professor of chemistry at Lehigh University, in charge of the department. Ralph J. Fogg, assistant professor in the department of civil engineering, has been made associate professor.

## *DISCUSSION AND CORRESPONDENCE*

### OCCURRENCE OF SILVER SCURF OF POTATOES IN THE SALT LAKE VALLEY, UTAH

WHILE making a plant disease survey in the Salt Lake Valley, Utah, during the past season the writer's attention was called to some diseased potatoes, which, upon examination, proved to be infected with the silver scurf fungus (*Spondylocladium atrovirens* Hartz). Microscopic examination of the organism together with the study of the fungus in pure culture proved its identity beyond a doubt. Both the conidial and sclerotial stages were found in great abundance on potato tubers collected from various parts of the valley. The conidia are dark brown and elongate-ovate with the apex narrowed and subhyaline. They are found to be five to eight celled, and average approximately 42 microns in length by about 8½ microns in diameter. A large number of measurements gave lengths ranging from 30 to 75 microns, and diameters ranging from 6 to 11 microns. The conidia are borne in more or less irregular whirls on the upper half of the conidiophores which vary considerably in length, but averaging about 125 microns. In addition to the characters of the fungus, the typical appearance of infected spots on the tubers leaves no doubt as to the identity of the disease; the silvery or glistening appearance of the spots showing very plainly. The presence of the minute black sclerotia is also very characteristic. Typical specimens of discolored, shrunken and shriveled tubers showing the later stages of the disease were also found in considerable abundance.

Very little is to be found on this disease in American plant pathological literature. It was first seen by Clinton[1] in 1907; Orton[2] mentions it as spreading rapidly in the eastern states; Melhus[3] states that the disease has been found on potatoes from Maine, Vermont, New York, Virginia, West Virginia,

[1] Clinton, G. P., Connecticut Agricultural Experiment Station, Annual Report, 1908.

[2] Orton, W. A., Farmers' Bulletin No. 544, U. S. Department of Agriculture.

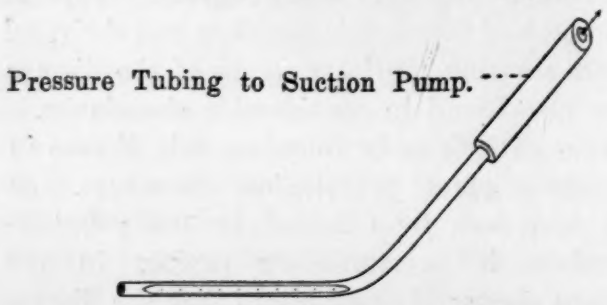
[3] Melhus, I. E., Circular No. 127, Bureau of Plant Industry, U. S. Department of Agriculture.

Florida, Wisconsin and Kansas. Recently silver scurf has been reported from Oregon[4] and Washington.[5] It has been very difficult to trace the introduction of this disease into Utah for the reason that the potato growers are not always informed as to the source of their seed tubers. In most cases the seed was said to have been purchased from other points within the state of Utah, but in some instances it was definitely ascertained that the seed came from Idaho. It is certain, therefore, that seed planted on new soil, with the resultant crop developing the disease, must have been infected previous to being planted. The writer believes that the silver scurf disease of the potato is widespread throughout the intermountain states particularly in Utah and Idaho.

P. J. O'Gara
Pathological Laboratory,
Dept. of Agricultural Investigations,
American Smelting and Refining Co.,
Salt Lake City, Utah,
December 9, 1914

## A SIMPLE DEVICE FOR COUNTING SEEDS

In preparing tests of seed germination a great deal of rather monotonous work is required in counting the seeds. The device to be described was worked out to obviate part of this labor, and has proved very efficient in our seed laboratory. In the hope that it will save valuable time for other workers in this field the following description is presented.




The seed counter is made from a piece of brass or copper tubing 20 cm. in length and about .5 cm. in diameter. This is bent in the middle at an angle of 45° and then on one side filed almost paper thin for a distance of 8 cm. At intervals of .7 cm. on this flattened side ten holes of suitable diameter are punched with a needle and hammer. One end of the tube on the side nearest the holes is sealed with solder or sealing wax, and the other end is connected by .5 cm. rubber pressure tubing to a small Richards air pump.

The seeds to be counted are placed in a flat tray and the pump started. The suction through the fine openings holds the seeds in lots of ten to the tube, which are removed by a flick of the finger. In case more than one seed adheres to a hole the extra ones can be quickly removed by tapping the tube, or with the finger. It will be found advisable to have tubes made up with various sizes of holes, one for small seeds such as tobacco, with openings as small as can be made with a No. 7 needle; one with medium-sized holes of .5 mm., which are best adapted to seeds of the size of radish, clover, etc., and one with holes of 1 mm. in diameter. Seeds with a very rough exterior such as beet seed do not lend themselves well to this method of counting as the surface is too uneven to be held by the suction. Large seeds—beans, peas and corn for instance—are too heavy to be held by the suction produced by the small Richards pump, but there is no doubt that with a stronger suction such as that produced by a vacuum cleaner this method could be used in counting these heavier seeds.

Orton L. Clark
Massachusetts Agricultural
Experimental Station,
Amherst, Mass.,
November, 1914

## THE JOURNAL "ISIS"

To the Editor of Science: I beg to call your attention to one of the incidents of the war which is likely to be overlooked in the midst of all the excitement of daily battles and the destruction of life and property. I refer to the devotion to scholarship, to duty, and to educational ideals shown by Dr. G. Sarton, of Wondelgem-lez-Gand, editor of *Isis*, in continuing the publication of this im-

[4] Bailey, F. D., "Phytopathology," 4: 321–322, August, 1914.

[5] Rees, H. L., *Western Washington Experiment Station Bulletin*, 1: 15–16, 1914.

portant journal in spite of the invasion of his city and country, and under circumstances that must be most trying. *Isis* was founded in 1913, its purpose being to consider the historical development of all the various human disciplines, a field not covered by any other publication. It appears about four times a year, is edited in a dignified and thoroughly scholarly manner, and takes rank with the best scientific periodicals of the day. Its articles appear in the four languages of the various international congresses, but the editorial matter is in French. It should have place in every general reading room, and particularly in the libraries of all institutions of higher learning.

It occurs to me that this is the time of all times to encourage a Belgian scholar of international standing, struggling to continue so important a publication. I have been glad to send my own subscription in advance, and I shall be glad to forward such subscriptions as may be sent to me. The price is $3 a year ($6 for Vol. I.) and if one should wish the journal from the beginning, $12 would pay for the back numbers and one year in advance.

I undertake this work merely to help a worthy cause, but without any personal guarantee as to the effect of the war upon the enterprise. I have been glad to send my own money, and I hope others will join in the worthy cause.

DAVID EUGENE SMITH

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

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## *SCIENTIFIC BOOKS*

*Anesthesia.* By JAMES TAYLOE GWATHMEY, M.D., and CHARLES BASKERVILLE, Ph.D., F.C.S. New York and London, D. Appleton and Co. 1914. Pp. xxxii + 945. Illustrated.

The subject of anesthesia in surgical operations has attracted the attention of medical men and others for three quarters of a century. Between 1840 and 1850 the successful use of ether was introduced in this country, and of chloroform in Great Britain. Although other substances were soon after recommended for general anesthesia, some of which came into limited use, these two well-known liquids have remained the standard agencies for the production of insensibility to pain in operations practically down to the present time.

In recent years, however, there has been a widening of the field, largely because of new discoveries and the introduction of local anesthetics to supplant, in many cases, the earlier ones with profound general effects. A voluminous literature has been accumulating, not only in the way of papers, but also in the form of longer treatises. Most of this has been of interest to medical men only and has been written for those engaged in some field of medical or surgical work.

But in this country the whole subject of anesthesia has become of more popular interest, as witness the discussions in the monthly magazines, and even in the daily press, on the subject of the "twilight sleep" in its relations to midwifery. At the present time the newspapers bring us many accounts of the difficulties of surgery on the European battlefields, where the supply of ether and chloroform is sometimes insufficient for the needs. Medical men and laymen alike have been ready for a discussion of the whole subject of anesthesia along somewhat broader lines than obtained in the past literature, and such a discussion is found in the work which is the subject of this review. The authors bring a wide range of experience to the task. One of them is a specialist who has done much to perfect the technique of the administration of certain anesthetics, and who has been one of the foremost advocates of the proposition that the administration of an anesthetic is in itself an operation calling for special skill and experience, and which should not be turned over to any interne or advanced student who happens to be at hand. The other author is one of our well-known chemists who has had an extended and unique experience in the preparation and the study of the properties of a group of pure anesthetics. He is the author of a number of valuable articles on the subject of pure anesthetics.

The work, therefore, brings evidence of

first-hand knowledge, trustworthy in detail. Besides this the recorded experience of prominent writers is condensed and presented in such a way as to make the book a reference work covering a wide range of topics, in which the historical treatment is a prominent feature. The literature references are very full and sufficient to afford the specialist a groundwork for following up the details of any given topic.

As much of the work in modern anesthesia is of a somewhat special character which could not be well covered by one or two writers, the authors have wisely called on men especially expert in their lines to contribute certain chapters. In this way anesthesia by colonic absorption, local anesthesia, intravenous anesthesia and spinal analgesia and spinal anesthesia have been specially treated. Some of these topics, the last one for example, have been much debated and the authors have presented the views of the opponents as well as the friends of the innovations. It can not be said that a partisan attitude appears markedly anywhere in the book. There are also chapters on the application of hypnotism and mental suggestion to the production of anesthesia, and one on the medico-legal status of the anesthetist. The reviewer will not attempt to pass on the merits of these more special discussions. They are referred to in order to give an idea of the range of topics covered in the work.

Of more special interest to chemists and the general scientist are the chapters giving lists of all the anesthetics which have been in use, with extended notes on the properties and behavior of the more important ones. The discussions on the chemistry of ether and chloroform are especially full. Here we find a good summary of the work of Dr. Baskerville. There can be no question of the value of this part of the work to any one who wishes to become familiar with the chemical phases of the subject of anesthetics.

While the book, as a whole, will find its most numerous readers among medical men, it may be cordially recommended to the general scientific student who may be interested in securing a comprehensive view of the important field.

J. H. Long

*Food Products.* By Henry C. Sherman, Ph.D., Professor of Food Chemistry, Columbia University. New York, The Macmillan Company. 1914. Pp. 594. Price, $2.25.

The author's purpose is stated as follows: "In this volume it is sought to incorporate in the subject-matter of a general study of foods the results of these recent advances which heretofore have been too widely scattered to be readily accessible." The author's experience as a teacher has shown him how difficult it is to find the material one needs for a comprehensive study of foods. He has rendered important service to his fellow teachers and to all who are interested in the scientific study of foods in putting into one book so much valuable material for reference.

His discussion of the nutritive value and place in the diet of the different types of food is, as one would expect of the author of "Food and Nutrition," a particularly strong, clear and authoritative interpretation of the recent advances in the study of nutrition.

The reviewer feels that the value of the material as a text book would be improved by placing the chapter on Food Legislation in the appendix along with the Rules and Regulations for the Enforcement of the Food and Drugs Act. She also suggests that Chapter IX. should precede Chapter VIII., or at least that the general statements concerning vegetables should be given before the discussion of any part of the group. It seems a little strange, with the author's leaning toward chemistry, that he does not suggest a chemical classification of vegetables in addition to the others given. One wonders why the discussion of the starches was not followed directly by that of the sugars instead of placing fats and oils between. However, the arrangement of material, concerning which there is a great difference of opinion, is a very minor matter in comparison with the advantage of having at hand for reference so admirable a book.

Isabel Bevier

University of Illinois

*The Naturalist's Directory.* Compiled in 1914. Salem, Samuel E. Cassino, 1914.

This used to be a book useful to all naturalists, and there is no good reason why it should not continue to be so if the work were well done and the data edited with reasonable care. The new edition leaves one under the impression that the care taken with it was limited in amount and poor in quality. At page 127 under the general head of the scientific societies of the United States and Canada, and under the subhead "California" are given nine Canadian societies, while one other Canadian society is given on page 129 under the subhead "Canada." Under the "District of Columbia" at page 128 only one society is given; three others are put under "Canada" on page 129. The American Association for the Advancement of Science is listed under Massachusetts at page 130. The names and addresses in some of the foreign countries contain an unusually large number of errors. In one of those countries eight names and addresses contain twenty typographic errors. One only needs to look for the names of a few of the scientific societies he knows of or for a dozen or so of the naturalists he knows to find the weakness of the book. It is a great pity. A book such as this one pretends to be, and carefully edited, would be of great service to naturalists all over the world.

J. C. BRANNER

## *FRATERNITY GRADES AT PURDUE UNIVERSITY*

I HAVE read with considerable interest the recent article in SCIENCE on "Fraternities and Scholarships at the University of Illinois," by Professor Warnock, since a state of affairs somewhat similar to that he describes exists at Purdue University.

A report made in 1910 by the chairman of the committee on student organizations at Purdue showed a relatively low grade of scholarship in the fraternities. As no decimal grades are used on the registrar's books, the report took into account merely the percentage of A grades in the various groups. This average for the whole student body including the fraternities was 64 per cent.

The average for the honor fraternities, Tau Beta Phi and Alpha Zeta, was 85, and for one departmental fraternity, Triangle, 66 per cent.

All the other fraternities were below normal, ranging from 57 for Acacia to 31 for the solitary sorority. Furthermore, it was shown that although fraternity members constituted but 30 per cent. of the total attendance, 70 per cent. of all students dropped for poor scholarship were fraternity men.

The attention of the fraternities was called to this state of affairs and various efforts were made to stimulate greater interest in scholarship among the members.

The Alford trophy was first competed for in 1912 and won by the Delta Tau Delta. This is a bronze plaque suitably mounted and provided with a silver plate for inscriptions and was offered by Professor T. G. Alford. It is awarded each semester to the Greek-letter fraternity making the best record in scholarship, and must be won four times to give permanent possession. It has so far been held by the Delta Tau Delta, Phi Kappa Sigma, Sigma Phi Epsilon and Kappa Sigma.

In 1914, Professor James Troop offered a silver cup for special and honorary fraternities not eligible for the Alford trophy. This was won in the spring of 1914 by Alpha Gamma Rho, an agricultural fraternity.

A somewhat uniform plan for recording the monthly standing of their members was adopted by the various clubs and fraternities, and in general much more attention was paid to scholarship than had hitherto been the case.

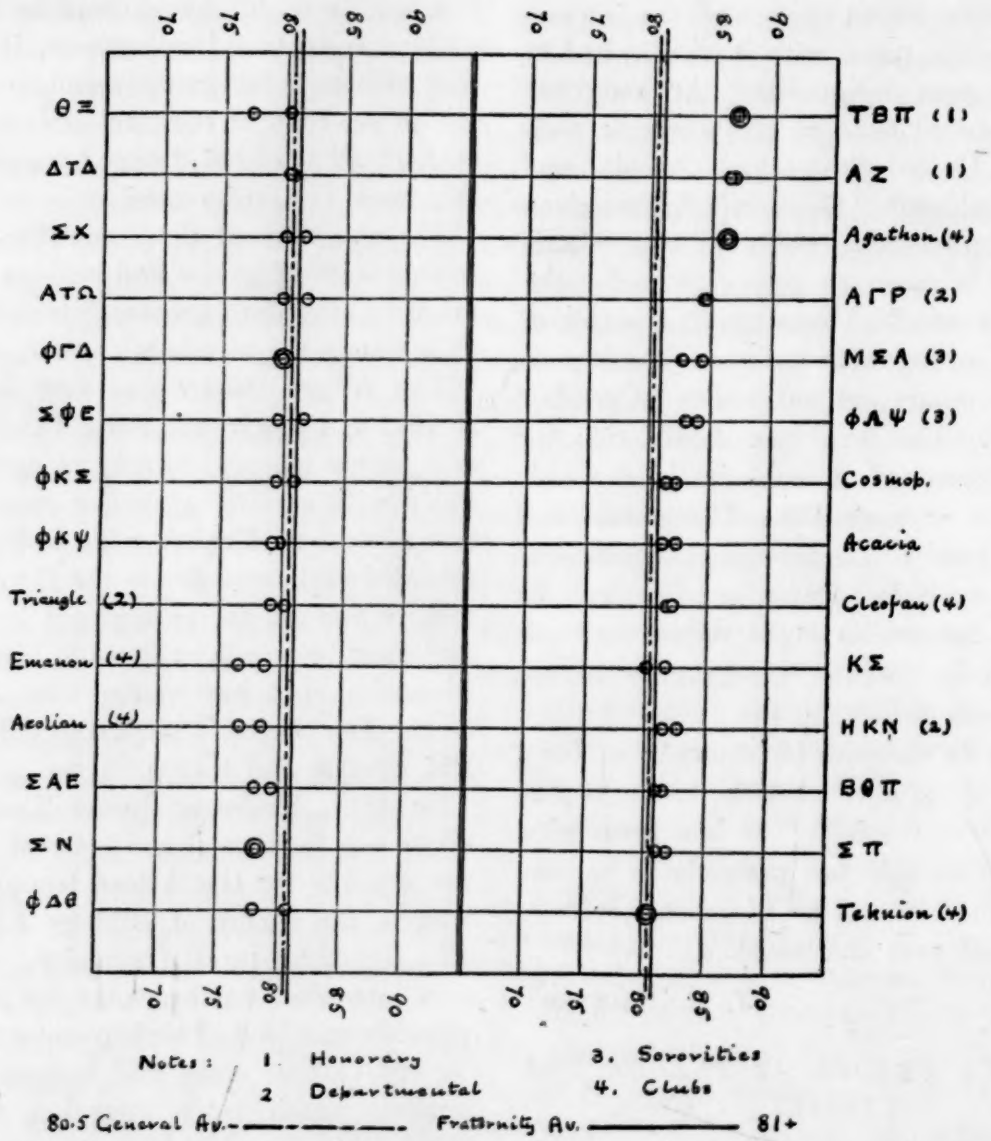
Besides the standings given out by the registrar's office in connection with the awarding of the trophies, decimal ratings for all fraternity and club members are prepared by the chairman of the committee on student organizations and sent to the respective chapters. Comparisons are made showing whether the members and the chapter as a whole are gaining or losing, and attention is called to the standing relative to other organizations.

As far as can be judged from the returns, the various agencies mentioned have stimu-

lated an interest in scholarship among the officers and members of the various organizations, with the result that the average standing of men inside the fraternities compares very favorably with that of non-fraternity men.

The organizations are arranged in the order corresponding to the grades for the second semester. Several comparisons are interesting:

1. The general average of the fraternities is half a point higher than the general student




Attention is here called to the accompanying chart, which shows the scholastic standing of the various clubs and fraternities as compared with the general student average for the first and second semesters of the college year 1913–14. The decimal grades were calculated from the letter grades for each student. At Purdue University A means 85 to 100 per cent., B 70 to 85 per cent., C below 70 (conditioned) and D failure (subject to be repeated). In calculating the decimal grades, A is taken as 90, B as 75, C as 60 and D as 45 per cent.

average. This, however, is due to the inclusion of the honor fraternities. Without these the averages would be practically equal.

2. The high standing of the sororities and the remarkable rise of the elder of the two, Phi Lambda Psi, from the bottom of the list in four years' time.

3. The lack of differentiation between departmental fraternities, house clubs and the regular Greek-letter fraternities as regards scholarship.

4. The relatively high rank of the Cosmo-

politan Club or Corda Fratres, considering that it is largely made up of foreigners more or less unfamiliar with our language and our educational methods.

Observation of the grades of various individuals and classes has shown that carelessness in pledging is largely responsible for fluctuations in scholarship. A sudden drop in the standing of an organization is usually due to the entrance of an inferior group of freshmen. Sometimes this one class will handicap the whole organization for several years. Otherwise the weeding out of incompetents and close supervision of the weak will remove the difficulty in a year's time. There is at the present time a general disposition on the part of the fraternities not to initiate pledges who are conditioned in any way.

A comparison of the class averages of fraternity men is made in the accompanying table:

*College Year 1913–1914*

| | Senior | Junior | Sopho-more | Fresh-man |
|---|---|---|---|---|
| First semester .... | 82.5 | 80.6 | 80.6 | 80 |
| Second semester ... | 83 | 81.1 | 80.5 | 79.7 |

The gradual elimination of the unfit and the survival of the fit is pretty closely shown by these figures.

When we come to study the records of individual organizations for a period of years, we find some interesting facts.

In 1912 the Sigma Pi, a new chapter, was at or near the bottom of the list with a grade of 76.3. Six months of determined work on the part of its officers and members put it tenth in a list of twenty-eight organizations with a grade of 81.9 and second in a list of thirteen Greek letter fraternities.

On the other hand, one of the house clubs through carelessness in its pledges and its house rules has dropped in one year from the fourth to the twenty-fourth place.

One of the fraternities, Sigma Nu, has remained consistently near the bottom of the list, never rising higher than No. 21 and being now No. 27 in a list of twenty-eight.

One of the other fraternities, Beta Theta Pi, has remained just as consistently in the upper middle section, its grade never falling below 80.4 and never rising above 81.5.

Of the four Greek letter fraternities winning the Alford trophy in successive semesters, the present rank in a list of thirteen is as follows:

| | |
|---|---|
| Delta Tau Delta | 4 |
| Phi Kappa Sigma | 9 |
| Sigma Phi Epsilon | 8 |
| Kappa Sigma | 1 |

a list which shows the rather violent fluctuations in rank occurring in a short period of time.

A comparison of the various classes or groups of organizations gives the following average grades for the two college years 1912–13 and 1913–14:

| | |
|---|---|
| (2) Honorary fraternities | 86.8 |
| (3) Departmental | 82.7 |
| (13) Greek letter | 80.1 |
| (2) Sororities | 83.5 |
| (4) Special fraternities | 80.5 |
| (4) House clubs | 81.2 |

The fraternity or social club suffers from certain tendencies which are more or less unavoidable in this kind of community life.

First, there is the disposition to choose pledges hastily and from considerations apart from the real value of the man. On the score of relationship, of social standing or of athletic prowess many candidates are chosen in haste and repented of at leisure.

Second, there is the tendency to relax the house rules and to permit more loafing, singing, smoking and card playing than is for the best interests of the organization. The more or less luxurious living and the feeling of boon companionship are too alluring for weak-kneed students who have not been used to such opportunities. This is a matter which any chapter can easily control if it wishes.

Third, there is the fact that fraternity men as a rule engage in student activities to a greater extent than do the non-fraternity men.

In 1911 the writer addressed letters to the deans of several neighboring universities, ask-

ing information as to the relative standing of fraternity men, reasons for any deficiencies which might exist and possible advantages to offset such deficiencies. Replies were received from the universities of Illinois, Iowa, Michigan, Wisconsin and Minnesota. Although there was naturally considerable variety of opinion, on the whole the replies were favorable to the fraternities, assuming that the latter were normal and were properly governed.

The grade of scholarship was generally admitted to be somewhat lower, but on the other hand it was conceded by most of the writers that fraternity men took a more active part in student affairs.

The accompanying table shows the conditions existing at Purdue and at Wisconsin in 1911 and it is possible that the relative values would be much the same to-day.

*Fraternity Men in Student Activities, 1911–1912*

| Activities | Purdue | | | Wisconsin | | |
|---|---|---|---|---|---|---|
| | Total | Frat. | % Frat. | Total | Frat. | % Frat. |
| Athletics—varsity | 38 | 15 | 39.5 | 83 | 39 | 47 |
| Publications (editors) | 24 | 7 | 29.2 | 95 | 56 | 59 |
| Music and drama | 18 | 9 | 50. | 89 | 62 | 69.7 |
| Class officers | 15 | 7 | 46.6 | 48 | 24 | 50 |
| Honorary societies | 46 | 8 | 17.4 | 42 | 7 | 16.7 |
| Totals | 141 | 46 | 32.6 av. | 357 | 188 | 52.7 av. |
| Per cent of students in university | | | 23.9 | | | 27.3 |

It will be noted that in all branches of activity but one the percentages of fraternity membership are higher than the percentage of total membership in the university.

In honorary societies, the fraternity membership is less.

On the whole, the fraternity man is one who is content with average rank and is ambitious for athletic, social or political rather than scholastic honors. He is a good fellow, and probably when he graduates knows more of college life and customs than his barbarian brother.

Men in fraternities and out are much the same intrinsically, and what difference there may be is due rather to environment than to character or ability.

C. H. Benjamin
Purdue University

## *How can we advance the scientific character of the work done in the American agricultural experiment stations?*

With the provision of the new Smith-Lever Fund for extension and demonstration in agriculture, with the increase in the already great number of farm advisers, with a thousand agencies for spreading information among the farmers, the experiment stations ought to be able at last to find and to occupy their proper field.

That field is research, the scientific investigation of questions connected directly or indirectly with agriculture. The demand for men capable of such work has always been greater than the supply of trained and able men. How shall we call men, and women, to this high service in increased numbers? And how retain them? These are the vital problems which confront the experiment stations; there are ways in which the great universities may aid the smaller ones in solving these problems.

Without going into the history of the experiment stations it is sufficient to point out that in the beginning their purpose was not clear even in the minds of most of the early workers: they were popular information bureaus in part, until they ran short of information. There has been a great deal of repetition and of compilation in their work: and, in looking over the earlier bulletins, we find little streaks of high-grade ore, pure investigation, the work of men in advance of their time, for the most part not appreciated, and misunderstood.

The mills of the gods grind slowly; now, out of those bulletins published in those earlier years, only the ones which were original in thought and method have survived; the rest served their temporary purpose and were forgotten.

To-day we are beginning to appreciate the value of investigation. In every state university, in every meeting of the Association of

American Agricultural Colleges and Experiment Stations we hear the insistent cry for more research, for more men capable of the scientific investigation of problems.

Where are we to find men, how are we to train men who have a natural aptitude for research? Under all the conditions prevailing in our state universities, their peculiar type of organization and government, how are we to create and to maintain an atmosphere in which genuinely free minds of high endowments and proven ability may work and grow, following research problems through years to their legitimate conclusions? In short, how are we to bring the experiment stations up to the level of the world's best work and thought in science?

The problem is a large one, it touches most vitally and most fundamentally the whole organization of the state university. It is a problem to be studied with the utmost earnestness: are there not ways in which the older universities with established standing may help the newer ones toward a solution?

Few educated men are in any true sense fitted for research and investigation. Much depends upon the training of the man; far more upon the natural gifts and endowments of his mind. It is so easy to endow a college with money: it is so hard to endow it with brains! Men of intelligence, men of rare natural gifts, may be attracted to an experiment station if conditions in the state university to which it is attached are favorable to a man's best development of his best self.

And what, then, are the favoring conditions which make possible in a university a high type of research? A careful canvass of the faculty of one of the larger and older institutions brought out the following opinions.

1. Non-interference with the time, the plans, and the work of the research man. This is a negative condition. Why should it be just the one thought of first of all? I think it is because it is the one condition hardest of all to obtain and hardest to maintain in the American state university.

Changes in boards of control and in administrative heads, changes in buildings and equipment brought about by rapid and poorly coordinated growth, pressure for results from researches which can bear fruit only after prolonged development and in the course of time, a lack of popular appreciation of the outstanding value of laborious, unselfish investigation, that itching for publicity which afflicts many estimable colleges, combinations of teaching or extension or other duties illmated with research, vexatious and disturbing financial systems—all these things and many others break into the time and thought of men engaged on research problems, oftentimes to the ruin of well-planned work.

Under such conditions many a piece of research, well-conceived and promising, has dwindled like a tree planted in a cellar, until it has died at last and borne no fruit.

Sometimes, too, the pressure for immediate results has led to shallow, popular work, or to a jumping at conclusions akin to quackery. Sometimes legislatures have been led to make great appropriations to such work because of its popular and flashy character; and their money has been wasted, their confidence impaired. Even in hurried America there is no way in which we can force the tree of knowledge to bear fruit before its season.

2. Another important set of conditions allied to the first is that supplied by the type of supervision and direction in vogue. In any research institution the only form of administration or direction which can be successful is the type implied in the word leadership. Above all other things, research, scientific investigation, is a product of the individual mind, or of a group of minds working on related aspects of the same subject. Research is original, original in method and means and in the end sought. If it is not original, then it is not research. No man can tell in advance what are to be his methods and what his results. If he can tell, then his work is not investigation at all; but demonstration, a retracing of the path found by other minds.

The whole trend of thought in college and station work in America indicates that the greatest responsibility of the leaders in administration, their duty and their pleasure,

must be to attract and to hold strong, independent minds, free in thought and fearless in character: and then, wholly subordinating the machinery of administration to the ends sought, to lead those minds into the best and highest and most original service of which they are capable. Good administration, like good literary style, sinks itself and loses itself in the things said and done, and in the work and thought.

In its relation to the whole university as a division or department of the larger whole it it evident that genuine research in the experiment station can progress only where the atmosphere of the university is just, thoughtful, conservative; and in accord with the best traditions of university life and thought.

I have spoken of two fundamental conditions, non-interference and leadership, which within the state universities will favor research of a high character. There are other favoring conditions which the universities of high development may establish from without for the benefit of the research spirit in the experiment stations. Let us discuss now two means by which they may exercise a profound influence for good. (1) Why may not the great universities regard the experiment stations as graduate schools? That is what they soon come to mean to the men who do research work in them under happy auspices. When the atmosphere of the university is favorable to research: when men are recognized and honored by their colleagues and by the administration because of the high character of the research papers which they have published, then the experiment station becomes a school, a higher university for the members of its staff. In many a university the young man working for his doctor's degree in regular course is not enough alone: he is not forced to draw heavily enough upon his own mental resources: to an extent hardly recognized, he may actually develop not his own ideas and lines of thought, but those of the teacher whose mind overshadows him. A research problem in an experiment station is a better test of what the man really knows and can do toward the development of that new knowledge which is advancement. In the experiment station the research worker must build his own road into the unknown.

I hope the time may come when the larger and older universities will be glad to place students of exceptional power and maturity and promise in the experiment stations to work upon special problems allied to agriculture in preparation for the doctor's degree. The station should furnish books, laboratory, equipment, money enough to enable the aspiring research student to live in relative comfort. But above all it should supply an atmosphere which would welcome and stimulate, and encourage the keenest thought and the bravest effort. Upon the completion of the work to a definite stage, it should be published as the station's contribution to knowledge in that field and as the thesis of the candidate for the doctorate. The completion of successful work giving evience of genuine ability would almost inevitably lead to the employment of the man somewhere in experiment station work. Thus the stations would enrich themselves by adding to their workers young men of demonstrated ability, of high ambition and marked promise, and of preparation under the most favorable conditions. (2) Yet another way in which colleges of high grade and established reputation may do much toward advancing the scientific character of the work done by the experiment stations is by conferring the doctor's degree on men now in station work whose bulletins form a genuine contribution to knowledge.

It is the writer's firm belief that no single agency and no combination of agencies will or can do so much for the elevation of the scientific work of the experiment stations as the interest and the cooperation of the older colleges with established reputations and fine traditions. The stations will strive then by every means in their power to make themselves worthy of such distinguished recognition and support. The treatment of accredited institutions as graduate schools and the prompt recognition of research work by the conferring of the doctor's degree will exert a continual and powerful influence for good upon

the character of the work done in the experiment stations.

SAMUEL BRADFORD DOTEN,
*Director Nevada Agricultural Experiment Station*
UNIVERSITY OF NEVADA,
October 19, 1914

## SPECIAL ARTICLES

### A DEVICE FOR PROJECTING A SMALL SPOT OF LIGHT SUITABLE FOR EXPLORING PHOTOSENSITIVE AREAS [1]

IN experimental work on light reactions the question of the precise location and extent of the photosensitive areas frequently presents itself. If the organism under observation happens to be small, or if minute sensitive elements are scattered in various parts of the integument, the problem has its difficulties. One of the obvious methods of attack is to explore the animal with a spot of light. To be of practical value for this sort of work the light spot must be small, clearly defined, and without halo, and it should be possible to direct it with the utmost ease and precision. Various devices have been employed for this purpose, none of which has proved entirely satisfactory. The use of a "pinhole" aperture does not give a sharply defined spot of light at a convenient working distance. An elaborate system of collecting and focusing lenses is expensive and is very likely to be cumbersome to handle. After trying various schemes, I found that by inserting a small tungsten bulb into a microscope in place of the ocular and projecting the rays through the objective, a spot of light could be produced which fulfilled the requirements admirably.[2]

The accompanying figure shows the details of the apparatus. A piece of brass tubing, *P*, is turned to fit into the draw-tube of the microscope in place of the ocular, a collar being left on it to prevent it from sliding in too far. Into the upper end of this tube is fitted a wooden plug, *X*, bored to take a small screw

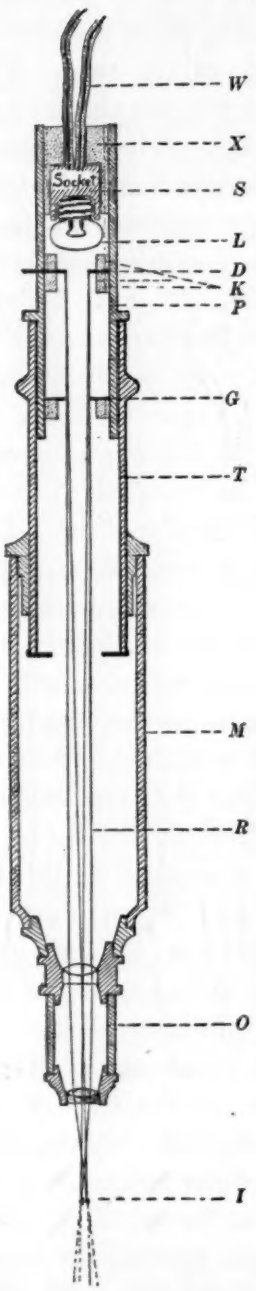



FIG. 1. A Device for Projecting a Small Spot of Light Suitable for Exploring Photosensitive Areas. *W*, wires from batteries to light; *X*, wooden plug fitted into the tube *P*, and bored to receive socket; *S*, screw socket for light; *L*, 2½-volt tungsten "flash-light" bulb; *D*, metal diaphragm with small circular aperture; *K*, cork collars holding diaphragm in place; *G*, diaphragm to cut out reflection from inside of tube, *P*; *P*, brass tube fitting into microscope in place of the ocular; *T*, draw-tube of microscope; *M*, barrel of microscope; *R*, construction lines indicating formation of the image, *I*; *O*, ocular; *I*, inverted and reduced image of aperture in diaphragm, *D*.

[1] From the Museum of Comparative Zoology, Harvard University, and the Anatomical Laboratory of the School of Medicine, Western Reserve University.

[2] The idea of utilizing the lenses of a microscope was suggested by Dr. Clark of the Physics department of Harvard University.

socket.[3] A two and one half volt tungsten bulb *L*, run by dry cell batteries furnishes the light. Immediately in front of the light a removable metal diaphragm, *D*, is inserted through a slot cut in the side of the tube. The aperture in the diaphragm has, for the sake of convenience and clearness in drawing the figure, been represented much larger than it is desirable to make it. A circular aperture of from one half a millimeter to a millimeter in diameter is a convenient size. If it is desirable to change the size of the light spot, a set of diaphragms of various sizes can easily be made. A second diaphragm, *G*, made of black cardboard and held in place by being cemented on to a cork collar should be inserted at the lower end of the tube carrying the light. This diaphragm serves to cut out any reflection from the inside of the tube. Its aperture should be about five times the diameter of that in the diaphragm, *D*. A low-power objective will be found most serviceable for projecting the light, as it brings it to focus at a distance from the microscope sufficient to allow the experimentor a clear field of vision in directing the spot. It has also the advantage of a greater depth of focus than a high power objective, making it much easier to keep the light spot in sharp focus on a moving animal. The adjustable *A** lenses are of about the right magnifying power and offer the additional advantage of allowing considerable variation in the size of the light spot without a change of diaphragms.

The spot of light produced by this apparatus is, of course, an image of the portion of tungsten filament not cut out by the diaphragm, *D*, reduced as many times as the objective magnifies, and projected at the focal point of the objective. By the use of a moderately high-powered lens the spot can be made as small as it is possible to follow with the naked eye, and absolutely without halo if the diaphragms are properly adjusted. It is at the same time very brilliant, and will be found to elicit a marked response from forms which are at all sensitive to stimulation by light. With it I have forced blow-fly larvæ to crawl in figure-of-eight loops only five or six centimeters in diameter.

In using the light to follow a moving animal, the barrel of the microscope is removed from the stand and held in the hand like a pencil. One can in this way direct the light with great ease and precision. I have found it so handled, very satisfactory both as a means of exploring for photosensitive areas and as a means of subjecting a limited region to continued stimulation while maintaining the surrounding tissues unstimulated.

Bradley M. Patten
School of Medicine,
Western Reserve University

[3] Sockets of a size which fits readily into a microscope and which receive the standard sized flash-light bulbs can be obtained of any electrical supply house under the name of "telephone booth sockets."

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## *THE AMERICAN PHYSIOLOGICAL SOCIETY*

The 27th annual meeting was held in the physiological laboratories of the Washington University Medical School, St. Louis, Mo., December 28–31, 1914. Fifty-six of the societies' 208 members were present. Five scientific sessions were held, three of these being joint meetings with the other societies of the federation, at which the following papers and demonstrations were presented:

W. B. Cannon, C. A. Binger and R. Fitz, "Experimental Hyperthyroidism."

H. R. Basinger and A. L. Tatum, "Studies on Experimental Cretinism."

W. L. Gaines, "The Action of Pituitrin on the Mammary Gland."

George B. Roth, "The Several Factors Involved in the Standardization of Pituitary Extracts."

H. C. Dallwig, A. C. Kolls and A. S. Loevenhart, "The Relation between the Erythrocytes and the Hemoglobin to the Oxygen of the Respired Air."

J. A. E. Eyster and W. J. Meek, "The Path of Conduction for the Cardiac Impulse between the Sino-auricular and the Aurico-ventricular Nodes."

C. Brooks and A. B. Luckhardt, "An Experimental and Critical Study of Blood Pressure Methods."

F. C. Becht and M. McGuigan, "Mechanical Factors in the Flow of Cerebro-spinal Fluid."

Katherine R. Drinker and C. K. Drinker, "The Effect of Rapid and Progressive Hemorrhage upon the Factors of Coagulation."

F. C. McLean, "On the Concentration of Sodium Chloride in the Serum and its Relation to the Rate of Excretion in Normal and Diabetic Men."

F. S. Lee and D. J. Edwards, "The Action of Certain Atmospheric Conditions on Blood Pressure and Heart Rate."

M. L. Fleisher and Leo Loeb, "The Lytic Action of Tissues on Blood Coagulum."

Ida H. Hyde, "The Influence of Light on the Development of Vorticella."

A. L. Beifeld, H. Wheelon and C. R. Lovelette, "The Effect of Pancreas Extract on Sympathetic Irritability."

B. H. Schlomovitz, J. A. E. Eyster and W. J. Meek, "Distribution of Chromotropic Vagus Fibers within the Sino-auricular Node."

Ida H. Hyde, "The Relation of the Nervous System to a Tunicate Larva."

J. R. Murlin and B. Kramer, "The Influence of Sodium Carbonate on the Glycosuria, Hyperglycæmia and the Respiratory Metabolism of Depancreatized Dogs."

J. J. R. Macleod, "The Possibility that some of the Hepatic Glycogen may Become converted into Other Substances than Dextrose."

R. T. Woodyatt, "Narcotics in Phlorhizin Diabetes."

R. S. Hoskins, "Adrenal Deficiency."

H. McGuigan, "Hypoglycæmia."

J. Auer and F. L. Gates, "Some Effects of Adrenalin when Injected into the Respiratory Tract."

R. W. Keeton and F. C. Koch, "The Distribution of Gastrin in the Body."

F. T. Rogers and L. L. Hardt, "The Relation of the Digestion Intractions to the Hunger Contractions of the Stomach (Dog, Man)."

F. D. Zeaman, J. Kohn and P. E. Howe, "Recuperation: Nitrogen Metabolism of a Man when Ingesting Successively a Non-protein and a Normal Diet after a Seven-day Fast."

H. C. Bradley, "Some Studies in Autolysis."

H. McGuigan and C. L. V. Hess, "The Diastase of the Blood."

W. E. Burge, "The Rate of Oxidation of Enzymes and their Corresponding Pro-enzymes."

C. Voegtlin, "The Harmful Effect of an Exclusive Vegetable Diet."

E. L. Opie and L. B. Alford, "Fat Infiltration of the Liver and Kidney induced by Diet."

V. H. Mottram, "On the Nature of the Hepatic Fatty Infiltration in Late Pregnancy and Early Lactation."

F. B. Kingsbury and E. T. Bell, "The Synthesis of Hippuric Acid in Experimental Tartrate Nephritis in the Rabbit."

C. Brooks and A. B. Luckhardt, "Blood Pressure Methods."

J. Erlanger and W. E. Garrey, "Demonstration of a Point-to-point Method for Analyzing Induction Shocks by Means of the String Galvanometer."

B. M. Patten, "A Device for Projecting a Small Spot of Light Suitable for Exploring Photo-sensitive Areas."

S. Amberg and D. McClure, "Demonstration of the Effect of Sodiumiodoxybenzoate on Inflammation Caused by Mustard Oil."

Worth Hale, "An Arrangement of the Porter Clock to give Three Time Intervals at the Same Time."

F. L. Gates, "A Portable Respiratory Machine Furnishing Continuous, Intermittent and Remittent Streams of Air."

P. A. Shaffer, "The Determination of Blood Sugar."

Eight papers were placed on the program to be read by title only. But besides these eight papers, sixteen additional communications placed on the program to be reported were read by title only, owing to the authors being absent from the meeting. It needs scarcely be pointed out that the failure of these 16 papers seriously marred the scientific program. The secretary hopes that this meeting will stand as the high water mark of the disgraceful habit of reporting papers to be read without going to the meeting to present them. In cases of unavoidable absence through sickness, the secretary should be notified, so that readjustments may be made even after the program is in print. And as for those who ask to be placed on the program and then choose to stay away from the meetings the secretary feels that the annual meetings of our society are too important to be made the subject of practical jokes of that type.

Some important changes in the constitution were adopted. The importance of research as *the* qualification for election to membership in the society was more explicitly emphasized. Voting by mail or proxy was abolished. The management of the *American Journal of Physiology,* owned and published by the society, was entrusted to the council; and the council was enlarged from five to seven members.

In recognition of Dr. W. T. Porter's great service to physiology in founding the *American Jour-*

*nal of Physiology* and successfully publishing it for many years, the council was entrusted to arrange for the dedication of a volume of the *Journal* to Dr. Porter.

The following persons were elected to membership in the society: A. Arkin, University of West Virginia; A. T. Cameron, University of Manitoba; P. M. Dawson, University of Wisconsin; C. M. Gruber and E. B. Krumbhaar, University of Pennsylvania; E. N. Harvey, Princeton University; H. L. Higgins, nutrition laboratory of the Carnegie Institution; Jessie L. King, Goucher College; F. C. McLean, Rockefeller Institute; S. Morgulis and E. L. Scott, Columbia University; G. B. Roth, Hygienic Laboratory, Washington.

*Officers for 1915*

*President*—W. B. Cannon.
*Secretary*—C. W. Greene.
*Treasurer*—J. Erlanger.
*Additional Members of the Council*—W. H. Howell, J. R. Macleod, W. E. Garrey, W. J. Meek.

Despite the unusual defaults in the matter of the scientific program, and the presence of only a few members from the Atlantic seaboard, the meeting was a success, due largely to the considerate efforts and the generous hospitality of the "local committee." The opportunity to inspect the new laboratories and the hospitals of Washington University Medical School by itself more than compensated for the trip to St. Louis. It appears that this school has actually made an advance beyond the "stone age" of the American universities in general. In material equipment for medical research and teaching, Washington University Medical School is second to none, if not superior to all other medical schools in this country.

A. J. Carlson,
*Secretary*

University of Chicago,
January, 1915

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## *THE AMERICAN MATHEMATICAL SOCIETY*

The twenty-first annual meeting of the society was held at Columbia University on Friday and Saturday, January 1–2, 1915, the attendance at the four sessions including 95 members, a considerable increase over previous records. The occasion was especially marked by the delivery of President Van Vleck's retiring address, the subject of which was "The rôle of the point-set theory in geometry and dynamics."

At the opening session President Van Vleck took the chair, being relieved by Vice-president L. P. Eisenhart and at the closing session by the President-elect, Professor E. W. Brown, and Vice-president Veblen. The following new members were elected: Dr. Florence E. Allen, University of Wisconsin; Dr. Nathan Altshiller, University of Washington; Dr. D. F. Barrow, University of Texas; Dr. R. B. Robbins, Sheffield Scientific School; Mr. C. H. Yeaton, University of Chicago. Fifteen applications for membership in the society were received.

At the annual election the following officers and members of the council were chosen:

*President*—E. W. Brown.
*Vice-presidents*—F. R. Moulton, Oswald Veblen.
*Secretary*—F. N. Cole.
*Treasurer*—J. H. Tanner.
*Librarian*—D. E. Smith.
*Committee of Publication*—F. N. Cole, Virgil Snyder, J. W. Young.
*Members of the Council*—G. D. Birkhoff, O. E. Glenn, R. G. D. Richardson, W. H. Roever.

The total membership of the society is now 722, including 72 life members. The treasurer's report shows a balance of $9,461.75. Sales of publications during the past year amounted to $1,843.67. The library now contains about 5,100 volumes, exclusive of unbound dissertations.

A most agreeable social concomitant of the annual meeting was the dinner and smoker at the Yale Club on Friday evening. Seventy members took advantage of this opportunity to renew and extend the acquaintance which is one of the valued objects of the society.

The following papers were read at this meeting:

L. P. Eisenhart: "Transformations of surfaces $\Omega$."

L. L. Silverman: "On the notion of summability for the limit of a function of a continuous variable."

A. B. Coble: "A configuration in finite geometry."

A. B. Coble: "The elliptic norm curve in $S_4$."

J. E. Rowe: "The symmetric and actual form of certain combinants of two binary $n$-ics."

Arthur Ranum: "On the differential geometry of the cyclic (circled) surfaces."

A. B. Frizell: "An enumeration of integral algebraic polynomials."

Dunham Jackson: "Expansion problems with irregular boundary conditions."

G. M. Green: "Hypersurfaces and families of curves defined by solutions of a partial differential equation of the second order."

Caroline E. Seely: "Certain non-linear integral equations."

E. B. Van Vleck, presidential address: "The rôle of the point-set theory in geometry and dynamics."

W. F. Osgood: "On the division of space of $n$ dimensions by a simple closed surface."

G. D. Birkhoff: "The functions of several variables defined by linear difference and differential equations."

G. D. Birkhoff: "Note on the reducibility of maps."

Virgil Snyder and F. R. Sharpe: "Certain quartic surfaces belonging to infinite discontinuous cremona groups."

H. S. Vandiver: "A property of cyclotomic integers and its relation to Fermat's last theorem."

J. L. Coolidge: "Circular transformations and complex space."

G. A. Miller: "Note on several theorems due to A. Capelli."

Edward Kasner: "The generalized concept of differential element."

F. N. Cole: "Note on solvable quintics."

G. C. Evans: "Note on the variation of a function depending on all the values of another function."

E. V. Huntington: "A set of postulates for elementary dynamics" (preliminary communication).

F. R. Moulton: "The solution of an infinite system of implicit functions."

C. N. Haskins: "On the roots of the incomplete gamma function."

W. C. Graustein: "On the geodesics and geodesic circles on a developable surface."

D. F. Barrow: "Oriented circles in space."

James Maclay: "A transformation of polynomials relatively to the exponents."

J. W. Alexander II: "A method for resolving the singularities of algebraic manifolds."

T. H. Gronwall: "On the summation method of de la Vallée-Poussin."

T. H. Gronwall: "An integral equation of the Volterra type."

T. H. Gronwall: "On the distortion in conformal representation."

The winter meeting of the society at Chicago was held on December 28–29. The next regular meeting of the society will be at Columbia University on February 27.

F. N. COLE,
*Secretary*

## *SOCIETIES AND ACADEMIES*

### THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 528th meeting was held in the Assembly hall of the Cosmos Club, October 17, 1914, with President Paul Bartsch in the chair.

Resolutions on the death of Theodore N. Gill, a founder and former president of the society, were presented.

Under the head of Brief Notes, etc., L. O. Howard presented evidence to show that, contrary to report, no birds had been killed in connection with arsenical spraying for the destruction of the gypsy moth in New England. Paul Bartsch reported that English sparrows destroyed many army worms on Washington lawns during the recent invasion by those insects.

The regular program followed.

*A Mouse that Lives in Treetops:* VERNON BAILEY.

An account of the history and habits of *Phenacomys longicauda* as observed by the speaker near Eugene, Oregon.

*Botanical Collecting in the Northwest:* A. S. HITCHCOCK.

A general account of a trip to the northwestern part of the United States and British Columbia during the past summer in search of grasses.

*The Present State of Fox-farming:* NED DEARBORN.

Observations made in Prince Edward Island and elsewhere during the past spring.

THE 529th meeting was held October 31, President Bartsch presiding.

The program consisted of two communications.

*Pelage Variations of American Moles:* HARTLEY H. T. JACKSON.

*Twenty Years' Experience with Great Apes of Western Africa:* R. L. GARNER.

Mr. Garner's lecture was profusely illustrated with lantern slides and gave much new information relative to African chimpanzees and gorillas.

THE 530th meeting was called to order by President Bartsch, November 14, 1914.

Brief notes were presented by Marcus M. Lyon, Jr., L. O. Howard, A. D. Hopkins and W. H. Osgood.

Three communications were presented.

*Certain Miocene Fossils:* WM. PALMER.

The fossils exhibited were obtained by the speaker at the cliff deposits near Chesapeake Beach, Md. Owing to the scanty material on which Cope's types in the Philadelphia Academy

were based, it was frequently impossible to identify the material collected.

*Arabic Zoology:* Paul B. Popenoe.

A sketch of the rise of Arabic zoology, with curious extracts from the treatise on the subject "Hayat al Hayawan" by Kamal al Din Muhammad ibu Musa al Damiri, published in the fourteenth century and still the standard authority among Moslems.

*A National Bird Census:* Wells W. Cooke.

An account of the plans followed and results obtained last June in an attempt by the Biological Survey in cooperation with ornithologists to count the birds that nest within the United States.

The 531st meeting was held November 28, with President Bartsch in the chair.

Under the heading Brief Notes, Dr. J. W. Stiles gave a brief account of experience in sanitation in relation to hookworm disease.

Wm. Palmer exhibited some interesting fossils from the Miocene deposits near Chesapeake Beach, collected during the past week.

Three communications were presented.

*A Porcupine Skull Showing an Extra Pair of Upper Incisors:* Marcus M. Lyon, Jr.

The specimen under consideration is believed to be unique. It was collected by Dr. Abbott in Borneo. The extra incisor was regarded as a persistent milk tooth. Lantern slide pictures of the skull were shown.

*Notes on Some Fishes Collected by Dr. Mearns in the Colorado River:* J. O. Snyder.

The species found in the Colorado basin are distinct from species found elsewhere. The faunas of other river basins of the West show the same feature. From evidence shown by genera the speaker concluded that communication between the basins must have been at a very remote period and by way of the head waters. He exhibited specimens taken by Dr. Mearns.

*Notes on Some Birds Observed on the Florida Keys in April, 1914.*

Observations as related to birds seen during an 8 days' cruise among the Florida Keys last April. Most of the stay was at Bird Key. Lantern slides were used in illustration.

The 532d regular and 35th annual meeting was held December 12, 1914, President Bartsch presiding. The annual reports of officers were received.

The election of officers for 1915 resulted in the following selections:

*President*—Paul Bartsch.

*Vice-presidents*—A. D. Hopkins, W. P. Hay, J. N. Rose, Mary J. Rathbun.

*Recording Secretary*—Marcus M. Lyon, Jr.

*Corresponding Secretary*—W. L. McAtee.

*Treasurer*—Wells W. Cooke.

*Members of Council*—Hugh M. Smith, Vernon Bailey, Wm. Palmer, N. Hollister, J. W. Gidley.

D. E. Lantz,
*Recording Secretary*

## THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN

The first meeting of the Science Club of the University of Wisconsin was held at the University Club on January 6, 1915.

Professor Daniel W. Mead, of the department of hydraulic and sanitary engineering of the University of Wisconsin, gave an account of his visit to China last summer, where he and Col. W. L. Siebert, and Arthur P. Davis, chief of the U. S. Reclamation Service, were called by the Chinese government for consultation upon the problem of preventing floods and reclaiming for agriculture lands now inundated by rivers and the sea.

The lecture was devoted mainly to an account of the engineering works of the Chinese. These are for the most part ancient, as there has not only been no new construction but the ancient works have been allowed to fall into disrepair.

The most notable works of the Chinese are their bridges, walls for defense, and dikes, levees and canals for navigation, irrigation and protection against floods. These are characterized by enormous expenditure of labor and material in their construction. Evidences of the ignorance and superstition of the constructors abound, and in many cases reduce the effectiveness of the works very materially.

The existing government in China recognizes the need for extensive reconstruction and extension of works for defense against the floods that destroy millions of the people each century. The visiting engineers were received with greatest respect and were afforded every facility for their work by representatives of the national and local governments.

The lecture was illustrated with many beautiful lantern slides prepared and colored by Japanese artists from photographs made by Professor Mead during his trip.

The meeting was preceded by a dinner at the University Club by members of the Science Club, their wives and guests.

Eric R. Miller,
*Secretary*